# ENGINEERING NEWS
AND
## AMERICAN RAILWAY JOURNAL.

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THE AMERICAN TRANS-CONTINENTAL ARC, as surveyed by the U. S. Coast and Geodetic Survey, has been completed. It lies along the 39th parallel, north latitude, and extends from a point near Cape May, on the Atlantic, to a point above San Francisco, on the Pacific coast. According to the measurements made the distance, reduced to sea-level, is 2,625.8 miles; and from these measurements the radius of the 39th parallel is yet to be determined. While this survey has cost about $1,000,000 in the aggregate, the longest base-line heretofore run is that across India, about 1,000 miles long. As compared with the radius of the 39th parallel, as given by Bessel, of Germany, this arc as measured is 111 ft. in error; and according to the figures of Andrew Clarke, of Glasgow University, it is 98½ ft. in error. But the Bureau claims that these variations are due to errors in previously established standards.

COMPRESSED AIR FOR OPERATING WAR-SHIPS is an innovation; but the U. S. Monitor "Terror" is so equipped and is said to be the only war-ship in the world that uses this power for turning its turrets, working the guns and steering the ship. Compressed air has been substituted for steam, or hydraulic power, because a leak in the pipes is not dangerous, and no exhaust pipes are required, as with both of the others. The "Terror" has two air-compressing engines, which can, singly or together, supply sufficient air at a pressure of 125 lbs. per sq. in. to operate both turrets. The air is carried to engines in each turret having 8-in. cylinders and 14-in. stroke, of about 40 HP. each. The shell-hoist is operated by another pneumatic cylinder, and the ramming is done by the same power. Compressed air also elevates or depresses the gun, and two pneumatic cylinders control the recoil. A similar engine is connected with the steering-gear, though a 5 HP. electric engine is also fitted for the same purpose. The "Terror" has passed her trial stage and the machinery operated by the compressed air has been found to work satisfactorily.

THE USE OF ELECTRICITY ON THE "FRAM," Nansen's exploring ship, is noted by the "Elektroteknish Tidsskuft," of Christiania. The dynamo was operated by a windmill and every puff of wind was utilized to load the accumulators. The current generated was used for incandescent and arc-lamps, and for firing the mining shots in clearing the "Fram" from ice. In extremely cold weather the solution used in connection with the accumulators froze solid, but the acid-blended ice was still useful in operating the accumulators and the cells were used until the cog-gearing in the windmill wore out.

THE WAR DEPARTMENT ESTIMATES, for the next fiscal year aggregate $52,875,638. The chief items in this estimate are as follows: Pay of army, $13,522,880; army subsistence, $1,659,837; quarter-masters' supplies, $2,200,000; army transportations, $2,500,000; clothing, $1,100,000; ordnance department, $1,131,000; military posts, national cemeteries and national parks, $1,558,380; national soldiers' homes, $3,443,214; rivers and harbors, $5,349,000. In regard to coast-defences, Secretary Lamont reports as follows: Within the last four years, 17 out of 21 12-in. emplacements, 55 out of 60 10-in. emplacements, 20 out of 25 8-in. emplacements, 14 out of 16 rapid-fire gun emplacements, and 92 out of 156 12-in. mortar emplacements, have been entirely provided for; while much work has also been done in the same time on those previously provided for. As nearly as can be gathered from the report, the government has now completed, or under construction, 71 12-in., 112 10-in. and 88 8-in. modern breech-loading rifled guns, and 109 12-in. rifled mortars, besides smaller guns. The all important question of gun-carriages has been practically settled and disappearing and non-disappearing carriages of an acceptable type are being furnished.

A SWORD FISH pierced 13 ins. of Oregon pine, forming part of the hull of the brigantine "Irmgard," on the late passage of that ship from Honolulu with a cargo of sugar. The sword passed through the 5-in. planking on the port bow and the 8-in. skin planking behind it, protruding 1 in. into the hold of the vessel. The planks were split for about 1 ft. each way, causing a leak. We give the above on the authority of the San Francisco "Examiner."

STEEL FERRY-BOATS, with twin-screws at both ends, are being built for the Pennsylvania R. R., to ply on the North River, from Jersey City to 23d St., New York city. The first of these boats, the "Pittsburgh," was launched from the Cramp shipyard on Oct. 17. The dimensions are—length over all, 206 ft. and 184 ft. between rudder-posts; moulded beam, 46 ft., and over guards, 65 ft.; average depth of hold, 15 ft. The hulls are made of steel with water-tight compartments, and there are two 3-cylinder compound engines with cylinders of 20, 32 and 32 ins. diameter and 24-in. stroke. Each engine will operate two screws 8 ft. 3 ins. in diameter on a continuous shaft. Water-tube boilers are used, with a working pressure of 200 lbs. A sister boat, the "St. Louis," will soon be launched from the yard of B. Hillman & Co., in Philadelphia.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision of passenger trains on the Florida Central & Peninsular R. R., at Swansea, Ga., Oct. 14. The southbound train had orders to pass the northbound train at Swansea, but the engineman read this as Sweden, a station 30 miles beyond. When the conductor found the train was running past Swansea he started to signal the engineman, but just at that time the collision occurred. Both engines were wrecked and the combination mail and baggage car of the southbound train was overturned and set on fire. The baggage master and mail clerk were burned to death and a brakeman who was crushed between the cars was also burned to death.—In a collision between a locomotive and an electric car at Hazleton, Pa., Oct. 14, three men were killed and nearly 30 injured, some fatally.

THE LOSS OF THE STEAMER "ARAGO" occurred Oct. 20 at the entrance to the harbor of Coos Bay, Oregon, during a heavy fog, and 12 persons (passengers and crew) were drowned. The vessel was owned by the Oregon Coal & Navigation Co., and was a steel steamer built by the Union Works, of San Francisco. It was 200 ft. long, 30 ft. beam, 16 ft. deep, of 947 tons gross tonnage.

THE FALL OF A CONCRETE DOME ROOF at the University of Virginia, Charlottesville, Va., on Oct. 19, resulted in the death of two men and the serious injuring of three others. The roof was a new one and the men were removing the falsework.

THE COLLAPSE OF A BRIDGE under a 15-ton steam roller occurred Oct. 14 at Watertown, N. Y. The engine was crossing the Knowlton bridge over Black River, when the bridge broke and the engine fell 30 ft. to the ground below, killing the engineman.

THE FLOOD PROTECTION DIKE at Corning, N. Y., has proved its efficiency during the recent freshet in the Chemung River. There were three unfinished places in the dike, but the Ferguson Contracting Co. kept gangs of men at work all night to fill the gaps. It is said that this is the first time that the Fifth Ward has not been flooded in time of high water.

EXCESSIVE SPEED OF ELECTRIC CARS is causing trouble at Hartford, Conn., and the Hartford Street Ry. Co. has been notified of the following results of an investigation made by Mr. A. W. Gilbert, City Electrician:

| | No. of Readings. | Per cent of total No. |
|---|---|---|
| Under 8 miles per hour | 5 | 3.0 |
| 8 to 10 " " " | 14 | 8.6 |
| 10 to 12 " " " | 47 | 29.0 |
| 12 to 14 " " " | 35 | 21.6 |
| 14 to 16 " " " | 36 | 22.2 |
| 16 to 20 " " " | 17 | 10.5 |
| Over 20 " " " | 8 | 4.9 |

THE BOSTON SUBWAY is to be leased to the West End Street Ry. Co., at an annual rental of 4.75% on its cost, which is not to exceed $7,000,000, the lease extending for 20 years. As the city pays a considerably less rate of interest (between 3 and 3½%) the difference between rentals and interest charges will constitute a sinking fund which will eventually pay off the capital borrowed by the city for the subway construction.

THE POWER OF LABOR UNIONS over public officials has recently been shown in Detroit. The board of supervisors is about to erect a new county building, and it received a letter from Mr. Garland, president of the Amalgamated Association of Iron and Steel Workers, asking that the contract for the iron and steel work be kept from the Carnegie Steel Co. In his letter he says:

> Since the memorable struggle with the company they have been cutting wages of the men in their employ and the market price of the material, and thereby making it harder for us to secure fair wages from union manufacturers. Even now they have demanded a reduction of their men, to take effect January 1. At the same time they are enjoying the benefits of a trust and holding up the price to $4 over a normal profit.

There appears to be a contradiction between the two statements that the company "is cutting the market price of the material" and that it is "holding up the price to $4 over a normal profit," but if so the supervisors seem to have overlooked it and they passed a resolution to the effect that none but union-made iron and steel work be used in the county building.

EIGHT DYNAMOS OF 500 K-W. each have been erected and started in the power-house of the Niagara Falls Hydraulic Power & Mfg. Co. in the gorge below the Falls. A description of this plant was given in our issue of March 26, 1896. The eight dynamos are driven by four Leffel turbines. The company expects to deliver power to the new aluminum works of the Pittsburg Reduction Co. in about two weeks.

BELGIAN PAVING BLOCKS to the number of about 15,000 have been imported by the New York Department of Public Works for use upon some streets of heavy traffic. The claim is made that they are more homogeneous in structure and wear better than blocks of native stone.

SEWER FLUSHING AT ROCHESTER, N. Y., has been discontinued. It seems that the work was at one time done by the Board of Health, which for some reason discontinued it. The Executive Board then took up the work, although not coming within its domain. Money for the work not being provided by the Common Council the Board has been obliged to discontinue the flushing.

LIMITATIONS OF THE CITY ENGINEER of Providence, R. I., are being considered by the Board of Aldermen of that city. It is proposed to restrict the engineer from doing outside work. The matter has been laid over until the last of October.

THE DRAWBAUGH TELEPHONE AND TELEGRAPH Company has applied to the Board of Electrical Control, of New York city, for a franchise to establish a telephone system. This company, of which Mr. J. R. Bartlett is president, contested for years the validity of the claims of Alexander Graham Bell as the inventor of the telephone and it is still engaged in legal controversy. As all attempts failed to establish Daniel Drawbaugh as the prior inventor, a bill is now before Congress, but not yet passed, asking that the Drawbaugh Company be permitted to use similar appliances to those now claimed by the Bell Company. It is in the hope that this bill will be favorably acted upon that the present company was incorporated on July 25, 1895.

INCRUSTATIONS IN WATER-PIPE, says "Le Genie Civil," were recently removed by fire, at Setif, as follows: Three pipes had been reduced in diameter from 1½ to 2¾ ins. by incrustation, and immersion in a bath of diluted hydrochloric acid had failed in useful result. Finally two lengths of pipe were placed on the ground parallel to each other, and 6½ ft. apart, and on these layers of 15 pipes were placed, each layer at right angles to the one below it, until there were 7 or 8 layers. Combustible material was filled in between the pipes and fired; and when the pipes were cooled they were easily scraped out and cleaned. Out of 137 pipes only 6 developed defects causing their rejection after the firing process, and the cost was about 3 cts. per lineal foot of pipe.

AROUND THE WORLD IN 33 DAYS is the possible pace set by Prince Hilkoff, the Russian Imperial Minister of Ways and Communication, now officially studying American railway methods. To make the circuit in this time modern fast ships and railway trains are alone considered; but with these available on the routes specified he gives the time as follows: New York to Bremen, 7 days; Bremen to St. Petersburgh by rail, 1½ days; St. Petersburgh to Vladivostock, by rail at 30 miles per hour, 10 days; Vladivostock to San Francisco, via Hakodate Straits, 10 days; San Francisco to New York, 4½ days. The present shortest time for circuiting the globe is given as follows: New York to Southampton, 6 days; Southampton to Brindisi, via Paris, 3½ days; Brindisi to Yokohama, via Suez, 42 days; Yokohama to San Francisco, 10 days, and San Francisco to New York, 4½ days, or 66 days in all.

## THE WATER SUPPLY SYSTEM OF SALT LAKE CITY, UTAH.

By W. P. Hardesty, C. E.
(With inset.)

Salt Lake City is exceptionally well situated to secure a good supply of pure water at moderate cost. The Wasatch Range of mountains lies close to the city on the east, and all along its western slope issue streams of pure mountain water, well fed by the snow, which lies on the highest peaks of the range till far into the summer. The creeks immediately contiguous to the city, and which were naturally first turned to for water, are:

(1) City Creek, which comes in from the northeast and enters the city and flows through the north side. (2) Emigration Creek, which comes in from the east. (3) Parley's Creek, which issues from the mountains southeast of the city. These creeks flow naturally westward through the city, emptying into the Jordan River, but their channels have been greatly changed and converted into irrigation canals, flumes, etc.

The water from all these creeks can, within a short distance from the town, be diverted so as to secure an all-gravity supply with an almost unlimited pressure. On account of the range of elevation, the north central, northeast and east central parts of the city naturally compose a zone for a high-line system, while the remainder can be covered by a low-line supply.

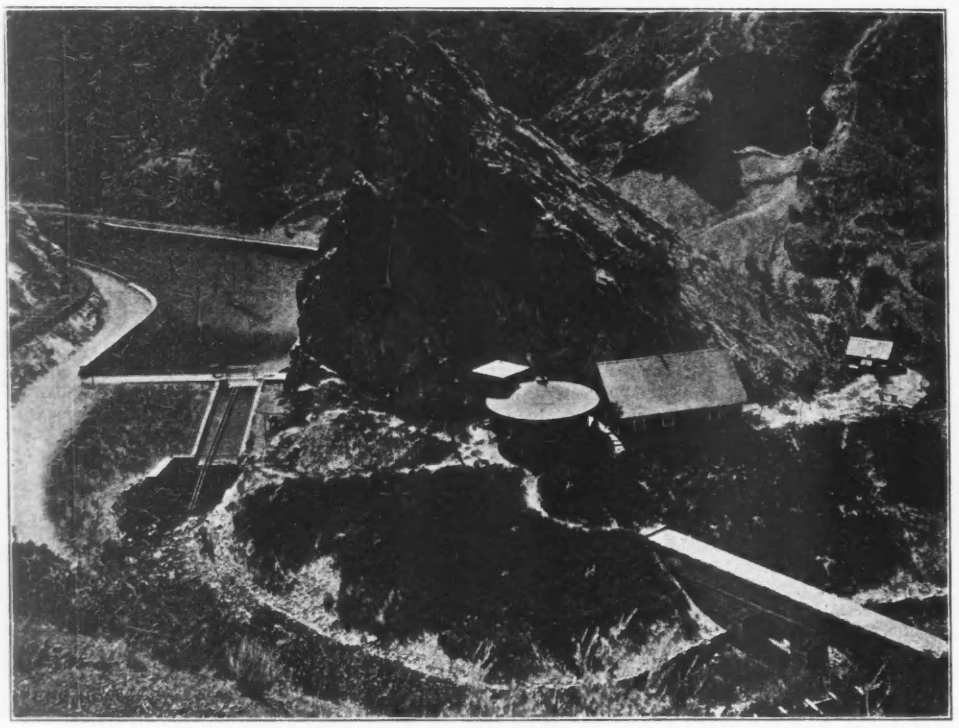


FIG. 1.—VIEW OF DAM, SCREENING TANK AND CULVERT AT HEAD OF PARLEY'S CREEK CONDUIT, SALT LAKE CITY.
A. F. Doremus, M. Am. Soc. C. E., Engineer.

The water supply system has always been owned by the city. The population of Salt Lake City increased from 20,768 in 1880 to 44,843 in 1890, and is now estimated at 50,000.

### City Creek Supply System.

This creek, being much the nearest and most available stream, was naturally turned to first for water for irrigation as well as domestic use. Indeed, the Mormons tapped this creek with a small irrigating ditch on the very day they arrived in Salt Lake Valley, July 24, 1847. All water brought by the city for domestic use came through open ditches, or from wells, until about the year 1872, when the creek was tapped by a pipe line. Wooden pipe was proposed at first, but cast-iron was soon substituted. This cost, then, about $100 per ton delivered in Salt Lake City. A 20-in. pipe was used for 1,900 ft., and a 16-in. pipe for 1,450 ft. more, which brought the line to the center of the city, no water being then drawn from it on the way down. In 1888, a line was taken out nearly one-half mile farther up the stream. The water is diverted by a weir, and after passing through screens for excluding leaves and drift is passed by a short tunnel through a projecting ridge in the valley to a brick tank on the creek below, used for a settling basin. This tank is divided into two compartments, so that either can have the water drawn off and be cleaned when necessary. It has a capacity of 220,000 gallons. From the tank a pipe line leads down the canyon to connect with the first pipe line. About 100 ft. of this pipe is 30-in. and the rest 24-in., reducing to 20 and 16 ins. in the first line.

It is told as a fact that Brigham Young and his lieutenants gave the pipe this diminishing size, from 30 to 16 ins., with the firm opinion that the momentum of the water (it was to gradually increase in velocity) would permit of this reduction in pipe cross-section.

In 1889 the 20th Ward pipe line was built. This takes water at about 130 ft. higher elevation than the low line. It consists of a 12-in. wooden pipe, wound spirally with flat bands and well tarred. On leaving the canyon bed, the pipe is changed from 12-in. wood to a 6-in. cast-iron (which climbs the side hills and runs east on 6th St.), and to an 8-in. kalameine pipe. This pipe line supplies the district between South Temple St. and 6th St., and from State St. east.

The high line supply from City Creek is taken out about 2½ miles above and nearly 500 ft. higher than the low line, and supplies the highest part of Salt Lake. The main is of 12-in. cast-iron, and just below the brick tank of the low-line system a Y is put in and a branch run up each side of the canyon onto the high ground. The branch on the east supplies the 13th St. system, which includes the district between 6th and 13th Sts., and between State and O Sts.

The only reservoir completed and now in use on the City Creek system is the one on Capitol Hill, on the west side of the canyon, fed by the west branch of the high line. This is 100 × 200 × 14 ft., is lined with concrete and cement; cost over $20,000 and holds 2,050,000 gallons.

The capacity of the pipes taking water from City Creek is about 14,000,000 gallons daily. The average minimum flow of the creek is about 7,000,000 gallons daily, with 4,000,000 gallons as the least flow recorded, in 1889. The natural flow has been much increased since then by tunneling and developing the springs and underflow.

Great care is taken in the canyon of this stream to guard against pollution. During the summer season the creek is regularly patrolled by watchmen in the employ of the city. The creek channel has been greatly improved by straightening and by rip-rapping its banks with stone. In this manner most of the vegetable matter and the debris have been excluded from the stream. The drift that does get into the stream is regularly cleaned out each season. The water, however, is hard, on account of the carbonates of lime and magnesia which also cause concretions, particularly in dead ends of pipes. Some of the very small mains used in this system are at an extreme disadvantage on account of these incrustations, being often nearly closed.

### Emigration Creek Supply.

This creek was tapped after the city had grown beyond the capacity of the City Creek supply. In 1890 a 12 and 14-in. kalamein iron pipe was laid from the creek just above the mouth of the canyon to a relief tank on the east bench in the city. This line is over three miles long and has a fall of about 300 ft. A trench 10 ft. wide and nearly 200 ft. long was dug across the bottom of the canyon with the intention of putting in a submerged dam and raising the water to the surface. It was found that the bed-rock in the lowest part was much deeper than was expected, and after going down 27 ft. the water had increased so fast that three pumps could not handle it, so this plan was abandoned.

A supply of about 800,000 gallons daily is obtained from that portion of the underflow reaching this trench that rises to the level of the inlet to the pipe here, near the top of the trench.

The natural summer flow of this creek is quite small and is rendered impure by the many flocks of sheep driven through the canyon. As a means of increasing the flow a tunnel was driven into the hill on the south side of the canyon at this same site. This tunnel is about 4½ ft. wide by 6 ft. high, and reaches in 306 ft. It cost about $5 per lin. ft. A flow of excellent water, estimated at 800,000 gallons daily, was thus developed. To secure the underflow it is proposed to start a tunnel about one-half mile down the canyon, at the mouth, and run up the canyon to the site of the dam. A ledge of rock extends diagonally across the valley here, though rather deeply buried in the center. It is believed that by constructing the tunnel with the head on the upper side of this ledge and at a sufficient distance below its top that the ledge, acting as a submerged dam, will collect all the water needed to be drawn off through the tunnel. Some borings have been made to define the profile of this ledge and ascertain the best location for the tunnel.

The conduit constructed is of 14-in. pipe, except about one mile of 12-in., used where the hydraulic grade is heavier. The crossing of Red Butte Creek (a small stream north of Emigration Creek) is made by laying the pipe in a box 16 ins. square inside. This box is very strongly built, and is packed with sawdust around the pipe. It spans the creek, having a mud sill as support at each end. The sides of the box are single, 8 × 16-in. pieces. The capacity of this pipe-line is about 3,000,000 gallons daily. It was built in 1890 and cost $51,000, of which the pipe and fittings cost about two-thirds, at the factory.

### Parley's Creek System.

It was in 1889 that Salt Lake City took on a new growth—a genuine western boom, and it was soon seen that the water supply was totally insufficient. Both Emigration and Parley's Creeks were suggested as new sources of supply, and the construction of the former in 1890 was followed by that of the latter in 1891-92. The mouth of Parley's Creek is over two miles south of that of Emigration Creek, and as the supply lines from both run northwest to the same point, the waters could just as well be united opposite the mouth of Emigration Creek canyon, making one line serve for both from that point to the city. This was not done for the reason that there was immediate need for more water, which could be secured quickly and cheaply by constructing the Emigration Creek line, and also for the reason that it was thought that this supply would be sufficient for a while, which, however, was not the case.

The Parley's Creek conduit has a length of over five miles, and it was made of sufficient size to

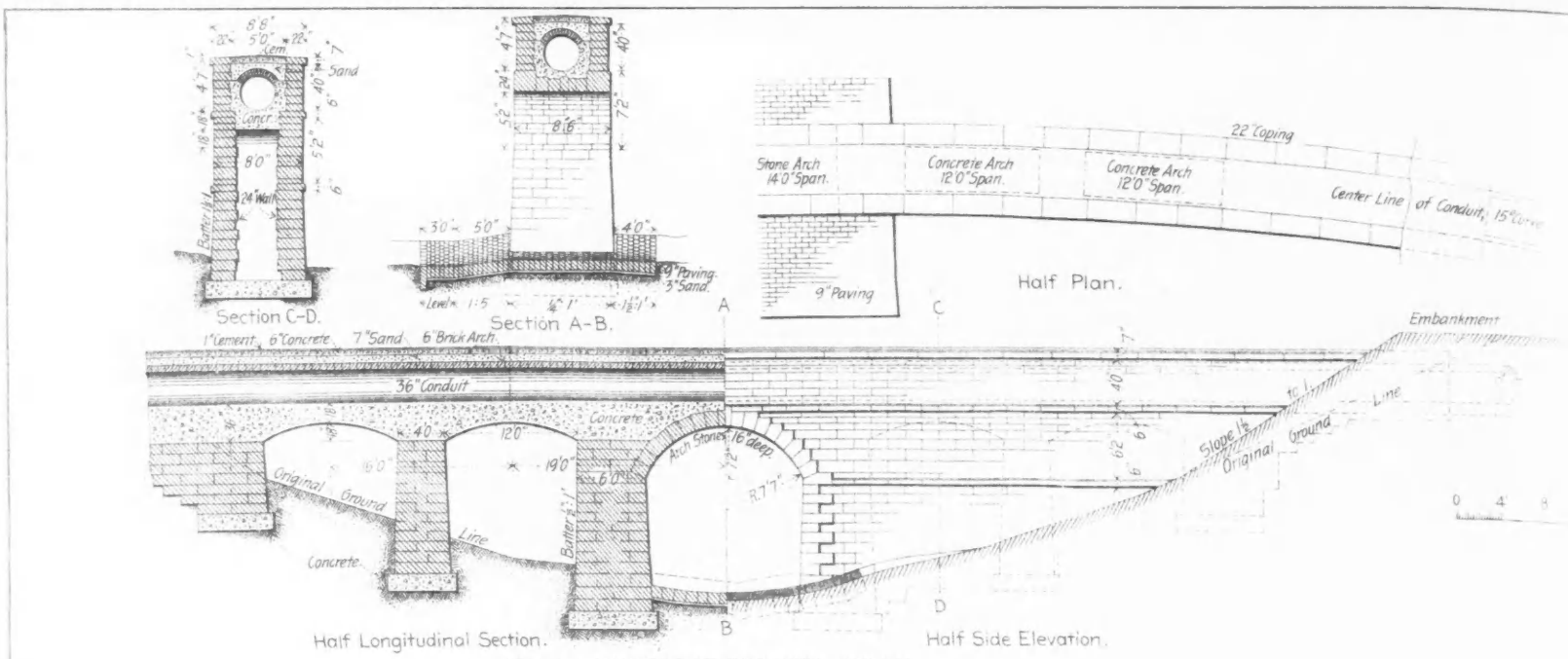



FIG. 6. CULVERT AT DUDLER'S GULCH.

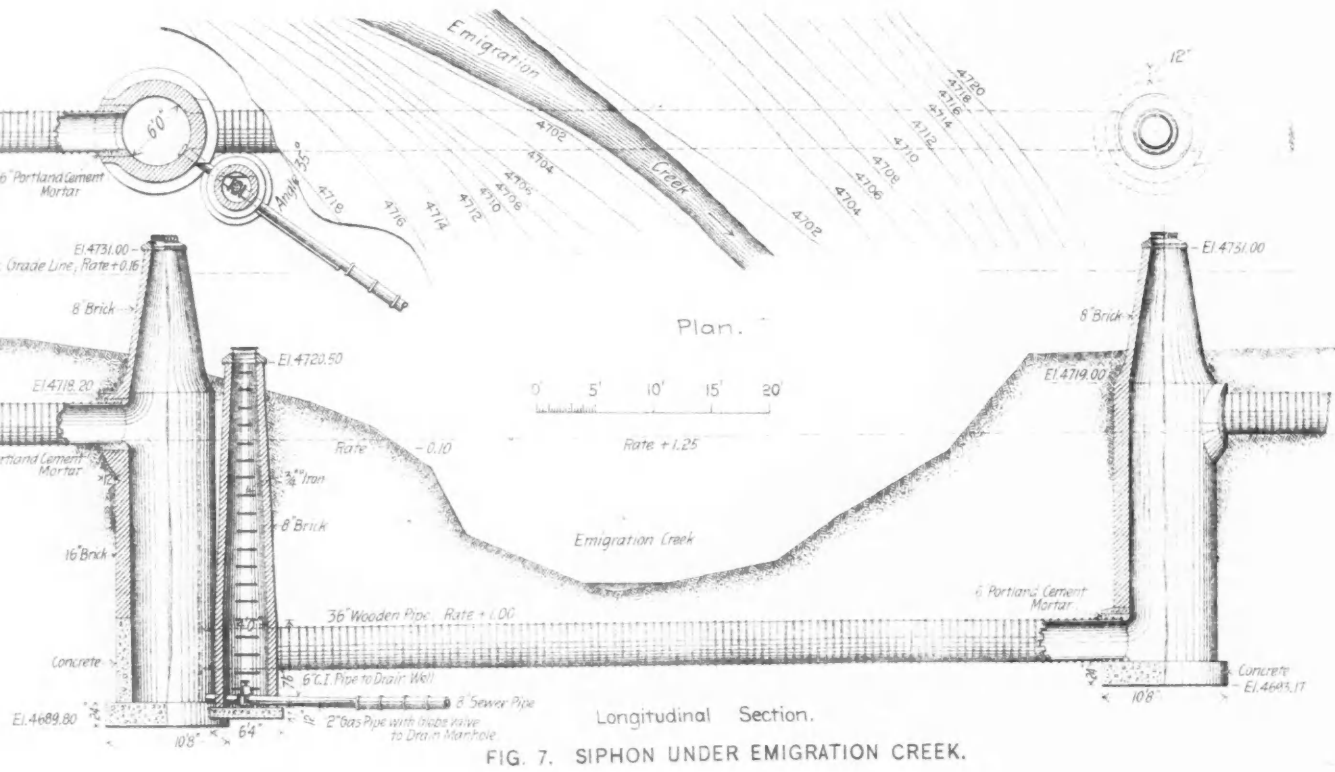



FIG. 7. SIPHON UNDER EMIGRATION CREEK.

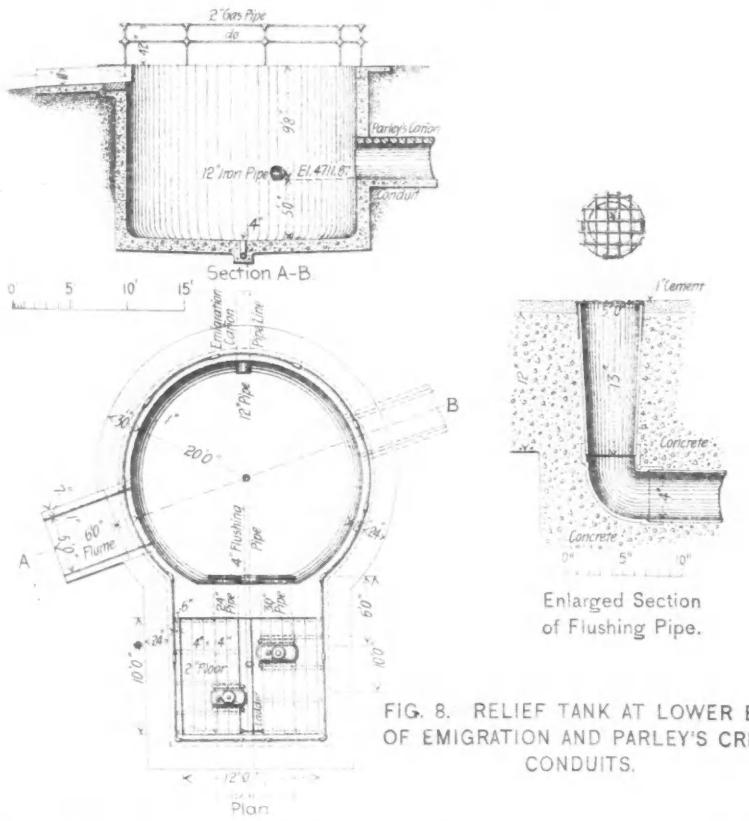
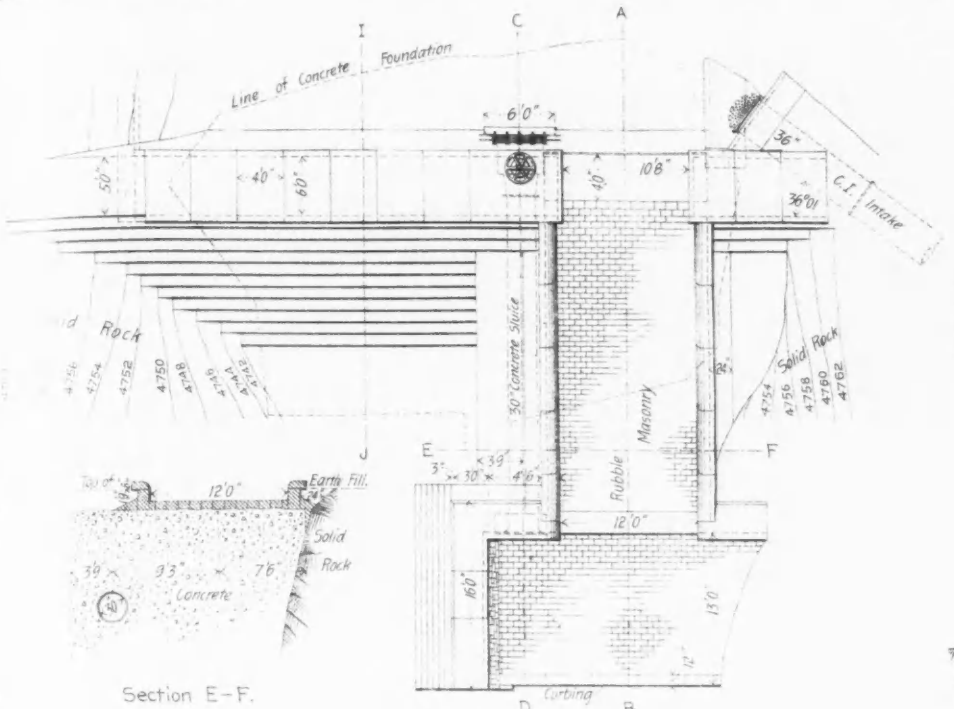
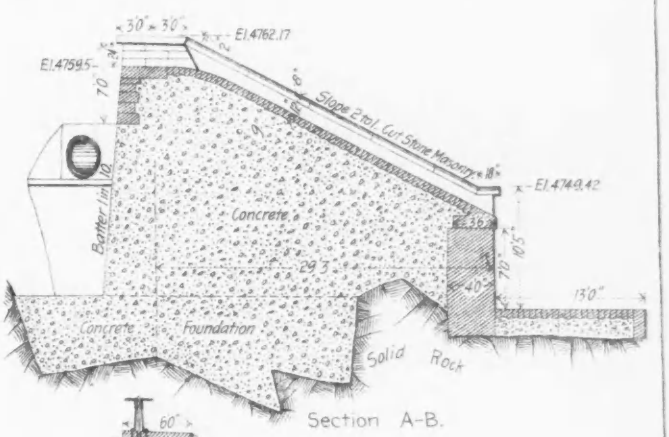


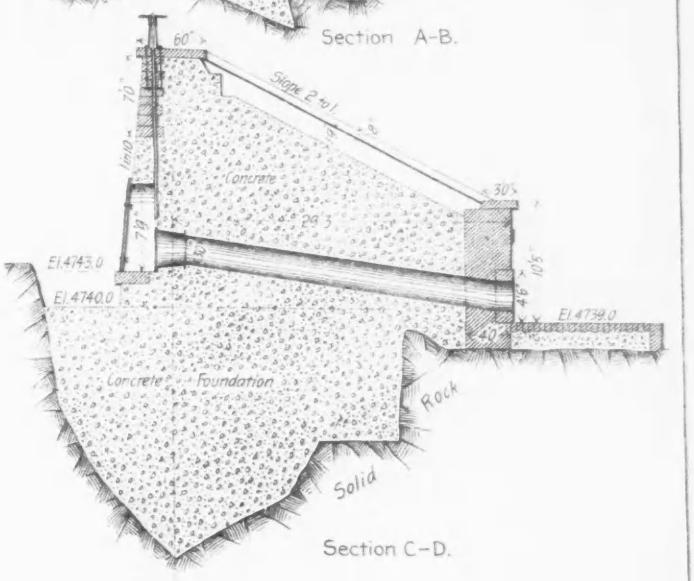

FIG. 8. RELIEF TANK AT LOWER END OF EMIGRATION AND PARLEY'S CREEK CONDUITS.

THE
WATER SUPPLY
SYSTEM
OF
SALT LAKE CITY,
UTAH.

A. F. Doremus,
M. Am. Soc. C. E.,
City Engineer.



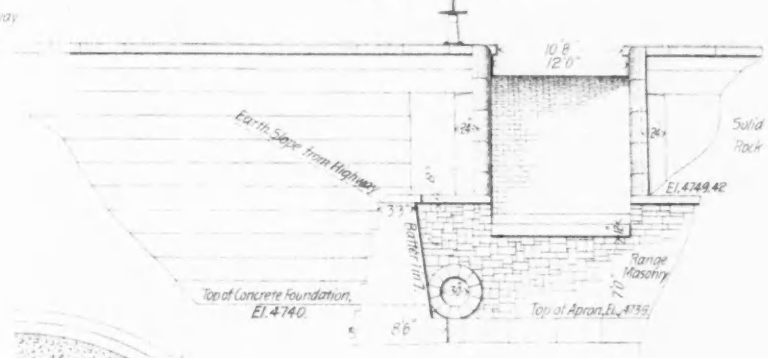
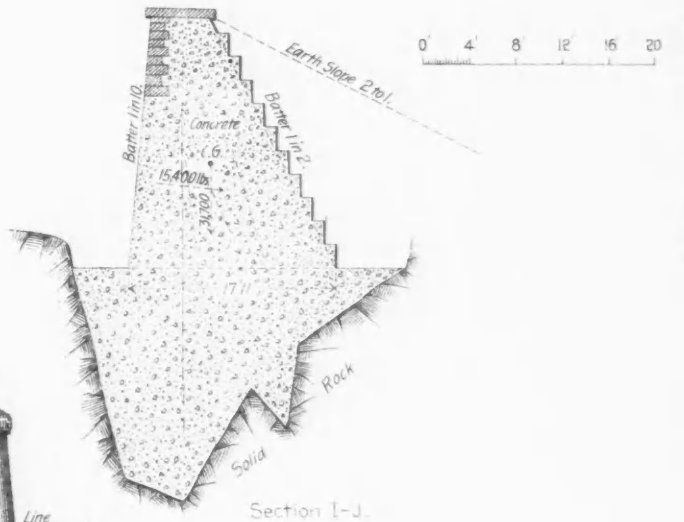
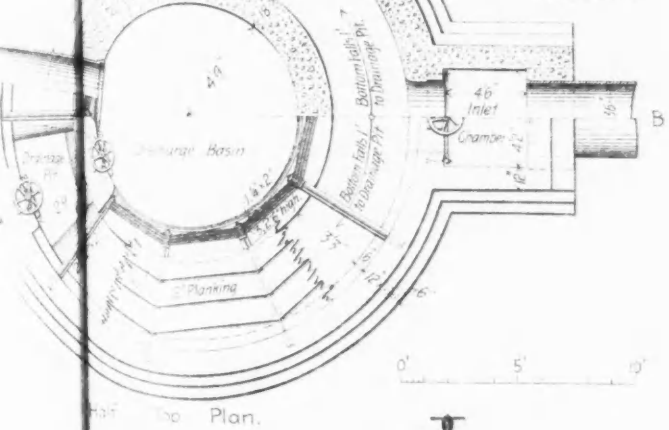
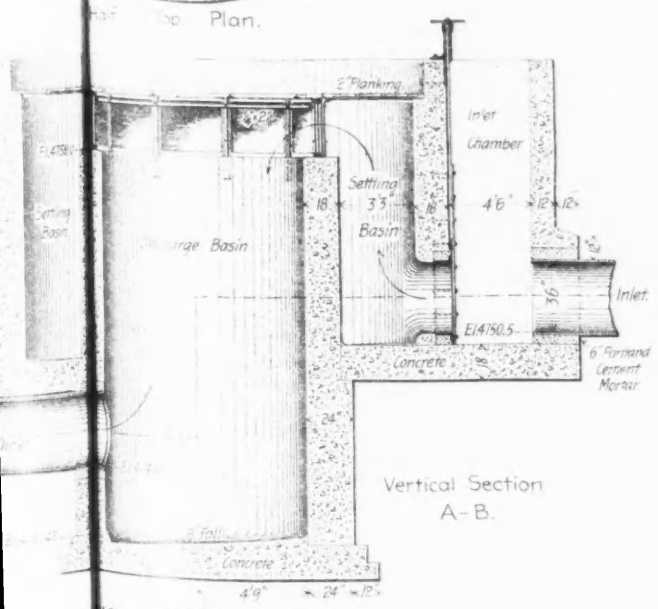
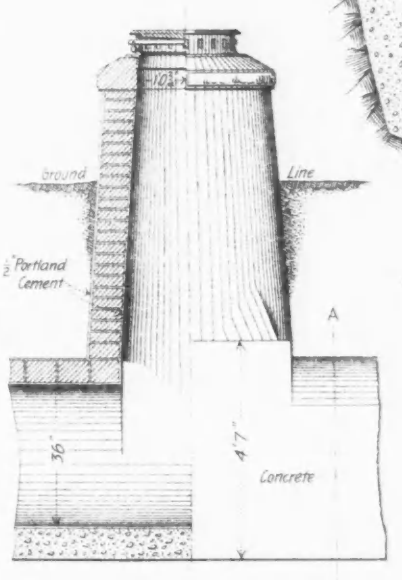



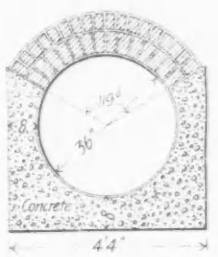

FIG. 3. DAM AT HEAD OF PARLEY'S CREEK CONDUIT.

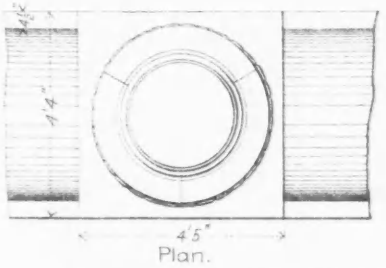


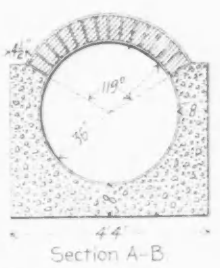




FIG. 4. SCREENING TANK.

FIG. 5. SECTIONS OF CONDUITS AND MANHOLE.

CHAS. HART & SONS, LITH., 35 VESEY ST., N. Y.

carry the waters of Mill Creek, the next creek south of Parley's, The conduit can be extended on to this creek with an additional length of about two miles. This will probably be done when necessary. Parley's Creek is tapped at the mouth of the canyon, at Sentinel Rock, where the opposite walls approach and make a natural dam-site. The head-works are shown by the two views, Figs. 1 and 2. The system consists of a settling basin, a stone dam, screen house and over five miles of 36-in. conduit. The conduit has a fall (of hydraulic grade line) of 0.16 ft. per 100, with a daily carrying capacity of 18,000,000 gallons.

The dam shown in detail by Fig. 3, on the inset sheet, is of concrete, with rubble masonry facing and cut stone coping, Portland cement being used. It has a water-way over its top and a 30-in. sluice underneath for passing surplus water. The crest of the spillway is 19½ ft. above the top of the foundation; its clear width is 12 ft., and the fall to the toe of the dam on the lower side is 20½ ft. Of this fall, 12½ ft. is down a 2 to 1 slope, and the balance of 8 ft. is a vertical drop, the water falling on an apron 13 ft. wide. The dam is 70 ft. long on top and the greatest width at the bottom is 34 ft., this being under the spillway.

The 30-in. sluice discharges the water near the bottom, and is controlled by a gate at the upper end. The upper side of the dam next to the spillway has a batter of 1 in 10, and the lower side of 1 in 2. The bottom width here is 18 ft., and the height, 22 ft.

The water is conveyed in a 36-in. cast-iron pipe, laid in a tunnel about 100 ft. long, and on the south side of the creek, from the upper side of the dam to the screening tank, both being at the foot of Sentinel Rock.

The tank, Fig. 4, consists of an annular settling basin, 3¼ ft. wide and 12½ ft. interior diameter, the water falling over the top of this into the circular discharge basin inside of it, the two basins being separated by an 18-in. wall, of an extra strong concrete, the parts being 1, 2 and 3. On top of this wall are the screens, through which all the water passes. This discharge basin is 9½ ft. by 16 ft. deep, and near its bottom the 36-in. outlet starts. The bottoms of both the settling and discharge basins slope in one direction toward a discharge pit, from which a 10-in. pipe leads for discharging sediment back into the creek. This pipe has a gate between the discharge basin and the pit, and one at the outlet to the latter. The screening tank is enclosed within a neat brick building.

From the discharge basin a 36-in. cast-iron pipe leads. The creek is crossed at once from south to north by a double stone culvert with 12-ft. arches, shown at the right of the view, Fig. 1. The pipe rests on concrete, which is carried halfway up its sides, the stone coping being all that is placed over its top. This pipe extends from the tank to the first manhole, a distance of 450 ft., and has a uniform ascending grade of 0.5% until the creek is crossed and then a grade of 3% to the manhole. This up grade is partly for the purpose of allowing sediment carried through the screens to deposit in the pipe, and when the inlet to the tank is closed and the discharge gate opened, the backward flow of the water in this pipe carries much sediment with it to be flushed out.

At the manhole begins the main conduit. This is a combination structure of concrete and brickwork, as shown by Fig. 5. The lower two-thirds is of concrete and the top one-third is of brickwork.

A special arch brick is used, having a depth of 6 ins., and but one ring is used. Where the conduit passes under a highway, an extra ring of common-sized brick is used over the 6-in. ring, to give added strength. The contract called for native cement for all the conduit, but after about ¾ mile had been built an agreement was made by which Portland cement was used for the concrete at the same price, the proportions of 1, 2 and 3 of the former being changed to 1, 4 and 5 of the latter. The bottom of the conduit, however, was still made with the native cement. Native cement, mostly Milwaukee or Utica, was used for all brickwork. The inside of the conduit is plastered with ½-in. of mortar of equal parts of sand and Portland cement. The maximum curvature for the conduit in the difficult work in the valley is 15°, while 3° and 4° curves are mostly used on the open ground.

Seven tunnels are used through the valley, ranging from 70 to 770 ft. in length, and with an aggregate length of 2,000 ft. These are used to go through the points of ridges. The material encountered was all earth. The summits above the tunnels range from 20 to 40 ft. The excavation was made 6 ft. high and wide enough to work in. Light cast-iron pipe is used through the two longer tunnels, amounting to 1,300 ft. in length, and the earth was backfilled around the pipe. It was deemed unsafe to use the concrete conduit here on account of a glacial movement of the earth, caused by its composition and by its being kept wet by seepage water.

Nearly one-half mile below the head is Dudler's gulch, which is crossed by a five-span arch culvert, shown by Fig. 6. Four of these are "blind" arches, and are of concrete with 12 ft. span, the arches being blinded with stone walls, while the center arch is of stone, of 14 ft. span and is open to pass the drainage.

The concrete arches are each 16 ins., and the stone arch 24 ins. thick on top, below the bottom grade 6 ft. above the creek, and with two 8-ft. blind arches.

At the intersection with 5th, 7th, 9th and 10th South Sts. the conduit is connected by lengths of 12-in. pipe with valve boxes, to be used for direct connection with the city pipe system when needed. The average cut made in open ground for this conduit was 8 ft., and 3 ft. is the least depth of covering over the top.

Brick manholes are placed every 800 ft. along the conduit. These have ventilators under the edges of the covers and a screen with ¼-in. meshes is placed below the cover of each manhole to prevent any large object that may get through the ventilators from falling into the conduit. The covers are provided with locks.

The ordinary sections of conduit cost $2.70 per lin. ft., while the contract price for wooden pipe, wrought-iron pipe and light cast-iron pipe were $3.45, $6.95 and $11.68, respectively, showing conclusively the economy of using the conduit in this case, to say nothing of its superior durability.

The Parley Creek conduit system was designed and built under the supervision of Mr. A. F. Doremus, M. Am. Soc. C. E., who was the city engineer from 1890 to 1894. Dubois & Williams,

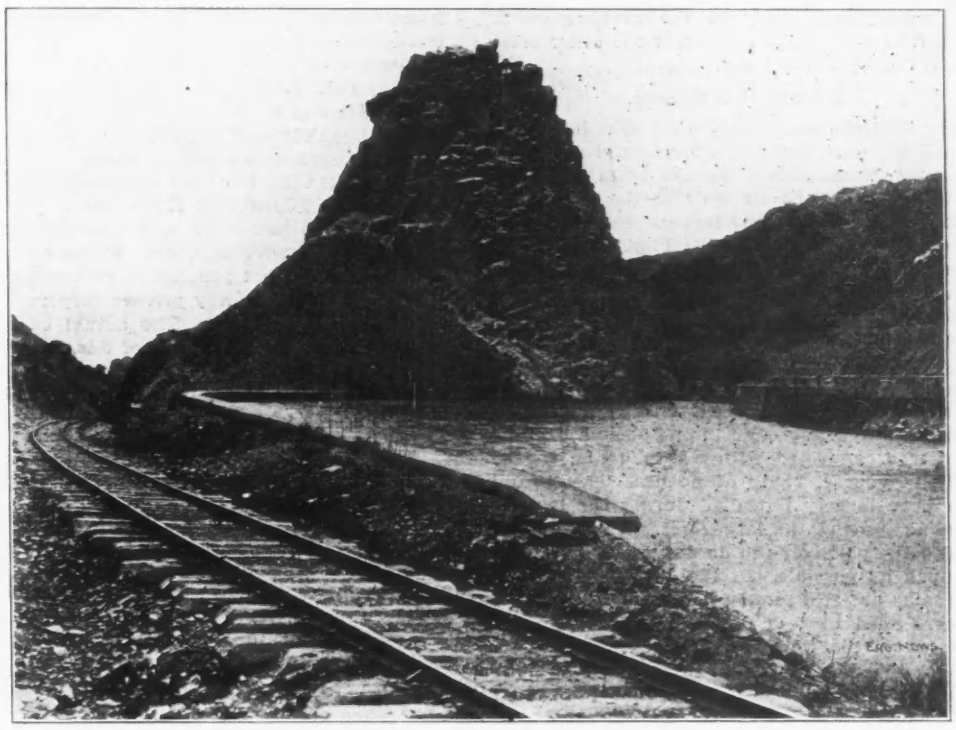


FIG. 2.—VIEW OF PARLEY'S CREEK HEAD-WORKS FROM UP-STREAM SIDE.

of Denver, Colo., were the contractors for all the work, except excavation and backfilling. In design and in the excellent and substantial character of construction, this system will compare favorably with any to be found in this country.

The entire cost of this system was $181,000, of which $34,000 went to contractors for excavation, etc., $117,000 for the masonry and constructed parts of the system, including pipes; $10,000 for engineering and $4,000 for inspection; right of way and additional work by other parties on the conduit taking up the balance.

The water from the conduit, and from the Emigration Creek pipe line, can be discharged into the relief tank, Fig. 8, on the east bench on the line of 1st South St. The pressure from the latter line must be relieved here before being turned into the low line system, as there is a fall of nearly 300 ft. from its head. The tank is 20 ft. in diameter and 14⅔ ft. deep. From the west side are projected two pipe lines, one of 24-in., leading to the 20th Ward pipe system, the other of 30-in., leading to 13th East St. reservoir, from there to be conducted into the low line supply system of the city. At present, however, water from the Emigration Creek line is not discharged into the relief tank at all, but is continued on past it and west on 1st South St. to supply the district between 8th and 13th East Sts. without relieving the pressure. An overflow pipe leads from the tank at a higher elevation than the

of the conduit. The width of the blind arches is 18 ft.; the stone walls are each 2 ft. thick, leaving a 4-ft. open space between, which was filled with earth and stone spalls, well packed. The piers between arches are solid. The standard construction of conduit is used, but 18-in. stone walls are used on the sides in addition, while over the brick arch is a regular pavement of sand, concrete and cement.

The arch of the center opening, the belt courses and coping are of cut stone, the rest of the masonry of coursed ashlar, quarry-faced. Portland cement is used in all these extra structures, except for the brickwork. The conduit here is on a 15° curve. A 9-in. stone pavement is used under the center opening for the drainage.

At about three miles from the head, Emigration Creek is crossed, by an inverted siphon, shown in detail by Fig. 7. This is a 36-in. redwood stave pipe, with steel bands. It is 546 ft. long, 313 ft. of this length being under a head of 12 to 15 ft., while the crossing of the creek bed proper is under a head of 33 ft. for a distance of 87 ft. At each end of this latter crossing is a deep brick well, giving a vertical drop in the siphon of over 19 ft. Adjoining the well at the north end is a valve pit, with an outlet pipe, by means of which the well and thereby the siphon is drained off when desired. This siphon pipe is buried about 3 ft. under the bed of the creek. Red Butte Creek is crossed with a 6-ft. open arch culvert, with a

other pipe, for discharging surplus water into the city irrigation system, near by. The tank and valve chambers are enclosed within a neat and substantial brick house.

The 13th East St. reservoir is only partly completed. It has yet to be lined before being of any service, and it will then hold about 6,000,000 gallons. It is located about 1,000 ft. west of the relief tank and is about 130 ft. lower. The water from the 30-in. pipe from the tank discharges through an 18-in. pipe and a flume into a wooden tank set within the reservoir and with its overflow at the same elevation as the overflow of the brick tank for the low line supply in City Creek canyon. They thus do not interfere with one another by discharging into the same pipe system. The relief tank is at the same elevation as the tank house in City Creek canyon, where water is taken out for the 20th Ward, so water from these two tanks can be turned into the same system without interference.

A 20-in. main leads from the reservoir west on 1st South St., being soon reduced to 18 ins., and then to 16 ins. at 8th East St., and extending to West Temple St., or over two miles.

The water of Parley's Creek is often very muddy during fall and winter, after rain or cloud bursts, and always so in the spring. On this account it is regularly used only in the summer season, when it is more clear and when the other creeks cannot supply the demand.

### Distribution System.

The greatest fault with the distribution system is the insufficient size of the mains and sub-mains. This was caused partly through ignorance of the city councils and partly because the system was built up piecemeal as the increased demand made necessary, not being planned broadly enough at the start.

On numerous streets the mains laid were only 3 and 4 ins., and from one of these as a trunk the laterals or branches would be laid. These were laid with dead ends, the system resembling a tree with projecting branches, only with the branches often larger than the parent trunk. There were 4 and 6-in. hydrants, and in one place a 6-in. hydrant was connected with a 2-in. main, the hydrant, of course, being of no use. These faults have been largely remedied during the last few years by putting in larger mains and by connecting the pipe so as to do away with dead ends as much as possible. In the 20th Ward system the mains are still mostly 3-in., and about 33,500 ft. here need to be replaced by 6-in pipe. The business part of town comes under the low line system, which supplies about two-thirds of all the water used. Following is a summary in round numbers of different sizes of pipe in the ground at this time:

| Size, ins. | No. ft. | Size, ins. | No. ft. |
|---|---|---|---|
| 30 | 110 | 10 | 3,500 |
| 24 | 2,620 | 8 | 33,000 |
| 20 | 2,400 | 6 | 341,000 |
| 18 | 3,700 | 4 | 138,000 |
| 16 | 9,100 | 3 | 61,000 |
| 14 | 11,900 | | |
| 12 | 38,000 | Total | 644,330 |

or about 122 miles. Besides this there have been over 7,000 ft. of 1½ and 2-in. pipe discontinued or abandoned. There have been placed about 1,425 valves and nearly 900 hydrants. The hydrants used are the Howe, Galvin and Ludlow. The Howe is an old type of hydrant that was made in Salt Lake. Nearly all of this make have been remodeled so as to make them effective. Those of 4-in. size are single and of 6-in. are triple nozzle. The Ludlow hydrants are 6 and 4-in., and are nearly all triple nozzles. The gates or valves used are the Boston, Ludlow and Galvin. The service pipes are all of lead, and are mostly ½ in., with ⅝-in. and ¾-in. for the larger houses.

The static pressure on Main St., in the business center of town, is 100 to 110 lbs. per sq. in. With a heavy draft during the summer the pressure often reduces to 60 to 65 lbs., while 90 to 100 is the average. By turning water from the 20th Ward system into the low-line here, the pressure is increased by 50 lbs. An ample supply with a strong fire pressure is thus secured. The Emigration or City Creek high-line system would increase the pressure to 250 lbs., entirely beyond the strength of the down-town pipes to withstand.

About 5,000 acres is reached by the supply system, thus taking in not less than 80% of the inhabitants. During the summer, when there is a large amount of water used for lawn and street sprinkling, the consumption reaches over 12,000,000 gallons daily, or 250 gallons per capita. During the winter the consumption does not reach over 8,000,000 gallons, daily, and the water of Parley's Creek is not then used. A very large amount of the water of the three creeks named was formerly used for irrigation, both for public irrigation of shade trees in the city and by private parties. In order to secure a supply to meet the demand for this irrigation water the city has for several years brought water through a large canal from the Jordan River, near Utah Lake, which is the source of this river and is about 30 miles south of the city. This water is used to supply irrigators in exchange for their water rights on Parley's Creek, and for the city's own uses. The lake will in time probably be the key to the solution of the problem of an increased water supply for domestic purposes, as water from it will have to be exchanged with pure water from the other mountain streams, these already being appropriated by farmers and millers. The minimum flow from the three creeks used occurred in 1889, when it fell to 8,000,000 gallons. The flow has been much increased by development of springs and other underground sources since then.

Considering all the possibilities in the way of supply, Salt Lake City should never have any serious trouble in obtaining sufficient water, even with a population of 500,000 or more. The value of the present water supply system, as an asset to Salt Lake City, has been variously estimated at $1,000,000 to $3,000,000; $2,000,000 is probably a safe figure to put it at, and it is doubtful if it could be bought for this, even if the constitution of the state did not prohibit it, as the people are violently opposed to any private corporation ever obtaining control of it. The actual cost of the plant has been but a fraction of this, though large sums have been spent on it at one time and another; but the water-rights and privileges and the ownership of much of the land in the valleys of the creeks are of the highest value.

## U. S. IMPORTS AND EXPORTS FOR 1893-1896.

U. S. imports and exports for 1893-96, inclusive, are reported upon, as follows, by the U. S. Department of Agriculture: During the ten years ending June 30, 1896, the United States exported domestic merchandise to the value of $8,207,292,566, and it re-exported articles of foreign crigin to the amount of $149,785,038, making our total exports in that decade, $8,357,077,604. Our imports during the same period were valued at $7,656,127,784; and the total commerce of the United States, for the ten years 1887-1896, was thus $16,013,205,388, or a yearly average of more than $1,600,000,000. The total exports for 1896 show an increase of $75,068,773 over 1895, and the imports an increase of $47,754,709, or an increase in total commerce of $122,823,482 over 1895, or about 8%. The figures for the present fiscal year also show an upward tendency, though this is not quite so marked as was the gain in the last fiscal year.

The exports of domestic merchandise, grouped by sources of production, are given for the years 1892-1896, inclusive, together with percentages of each group, as follows:

| Year. | Agriculture. | Manufactures. | Mining. | Forest. | Fisheries. | Miscellaneous. | Total for year. |
|---|---|---|---|---|---|---|---|
| 1891 | $642,751,344 | $168,927,315 | $22,054,970 | $28,715,713 | $6,208,577 | $3,612,364 | $872,270,283 |
| Per cent. | 73.69 | 19.37 | 2.53 | 3.29 | 0.71 | 0.41 | |
| 1892 | 799,328,232 | 158,510,937 | 20,692,885 | 27,957,423 | 5,403,587 | 3,838,947 | 1,015,732,011 |
| Per cent. | 78.69 | 15.61 | 2.04 | 2.75 | 0.53 | 0.38 | |
| 1893 | 615,382,986 | 158,023,118 | 20,020,026 | 28,127,113 | 5,541,378 | 3,936,164 | 831,030,785 |
| Per cent. | 74.05 | 19.02 | 2.41 | 3.38 | 0.67 | 0.47 | |
| 1894 | 628,363,038 | 183,728,808 | 20,449,508 | 28,000,629 | 4,261,020 | 4,400,944 | 869,204,937 |
| Per cent. | 72.28 | 21.14 | 2.35 | 3.22 | 0.49 | 0.52 | |
| 1895 | 553,210,026 | 183,595,743 | 18,509,814 | 28,576,235 | 5,328,807 | 4,171,974 | 793,392,599 |
| Per cent. | 69.73 | 23.14 | 2.33 | 3.61 | 0.67 | 0.52 | |
| 1896 | 569,841,714 | 228,480,893 | 20,412,153 | 33,718,204 | 6,585,814 | 4,152,709 | 863,200,487 |
| Per cent. | 66.02 | 26.47 | 2.37 | 3.91 | 0.76 | 0.47 | |

These figures show that in the fiscal year which ended last June, American farmers sold to foreign nations nearly $570,000,000 worth of their products, or about $17,000,000 more than in the preceding year. The sale of our manufactured products abroad grew faster still and their percentage of the total value of exports is now greater than for any year in the list; the gain of 1896 over 1895 being nearly $44,000,000.

The United Kingdom of Great Britain leads all other countries in exchanges with the United States. During the year ending June 30, 1896, we sold to the English speaking people of Europe merchandise valued at $406,000,000, or 46% of our total exports, and we bought from these people goods to the value of $170,000,000, or 22% of our total imports. Taking all parts of the British Empire in all continents, we find that they bought from us 58% of our last year's imports, aggregating in value $512,000,000. Next to England as purchasers come Germany, Canada, Italy, British Australia, British India, Japan, Russia and China, in about the order named. Our exports to Cuba have declined from $24,000,000 in 1893 to $7,500,000 in 1896, or only 31% of the value of the imports of 1893.

The value of imports for these six years, under the heads of dutiable and free, is thus given:

| Year. | Dutiable. | Free. | Total Imports. | Total customs collected. | Per cent of free. |
|---|---|---|---|---|---|
| 1891 | $478,074,844 | $366,241,352 | $844,916,196 | $219,522,205 | 43.3 |
| 1892 | 369,402,804 | 457,999,658 | 827,402,462 | 177,452,964 | 55.4 |
| 1893 | 421,856,711 | 444,544,211 | 866,400,922 | 203,355,017 | 51.3 |
| 1894 | 275,199,086 | 379,795,536 | 654,994,622 | 131,818,531 | 58.0 |
| 1895 | 368,736,170 | 363,233,795 | 731,969,965 | 152,158,617 | 49.6 |
| 1896 | 409,967,204 | 369,757,470 | 779,724,674 | 160,534,351 | 47.4 |

These figures show, for the year ending June 30, 1896, a gain of about $48,000,000 over 1895, and $125,000,000 over 1894, in the value of total imports. The articles that most contributed to the gain in imports last year were sugar, raw and manufactured wool, unmanufactured silk, wood and its manufactures, hides, tobacco, earthen, stone and chinaware, etc. We import most from England. As before stated we bought from her in 1896, goods to the value of $170,000,000; to this must be added the value of imports from her colonies, the aggregate being $259,000,000, or 33% of our total imports. After the United Kingdom comes Germany, Brazil, France, Canada, Cuba, Japan, China and British India, in the order named. Our imports from Cuba shrank from $79,000,000 in 1893 to $40,000,000 in 1896, and those from Mexico dropped in the same time from $34,000,000 to $17,000,000.

## MOMENTUM FRICTION BRAKE FOR ELECTRIC CARS.

The design of an efficient and simple momentum brake for electric cars, such as has been used on cable cars, possesses several features of difficulty, the chief of which, perhaps, has been the limited axle space left available by the motor casings. Only about 5 or 6 ins. of the car axle is ordinarily left clear by the casing, and this affords a very contracted space in which to apply suitable mechanism, and practically excludes the screw on the axle, such as, for instance, the Johnson brake for cable cars has. In a recent invention by Mr. W. G. Price, of the Chicago City Ry. Co., of Chicago, Ill., however, the difficulty is overcome, if a successful operation of six months in actual service is a good criterion from which to draw conclusions. Through the courtesy of the inventor we are able to present illustrations of this brake, which is called a momentum friction brake.

Fig. 1 is a plan and section of a four-wheel electric car truck, showing the location of the friction mechanism and brake rigging. A friction disk A, with a suitable hub runs loose on a sleeve keyed to the car axle close to the wheel, which is of special construction, having a disk on the inside, against which the friction disk bears, as is

clearly shown by Fig. 2. In the 2-in. annular recess in the friction disk hub are inserted the bifurcated ends of the levers, Fig. 3. These levers are located on the car as shown at B, Fig. 1. The operating rods C, Fig. 1, from the levers on the car platforms attach to the arm D, Fig. 1, shown in detail by Fig. 3—and this arm by its swing operates the screw, Fig. 3, so as to spread apart the lever ends resting in the annular recess, in a manner obvious from the drawing, Fig. 3. This spreading of the levers forces the friction disk, A, against the wheel, so that it turns with the wheel and winds up the chain E, Fig. 1, operating the wheel brakes, through the rigging, shown in Fig. 1.

When applying the brake the motorman pulls the lever a few inches toward him, and to release the brake he pushes it back again close to the dash of the car. When the brake shoes are properly adjusted a movement of the car of 18 ins. applies the brakes. It is adjusted by means of a ratchet on the head of the screw, and this adjustment can be done by the motorman in five minutes' time. The brake is oiled by means of an attached oil cup, which requires filling only once a week. Mr. Price states that the brake can be applied as quickly as an air brake, and works fully as smoothly by using the bend in the lever rods, as shown. Its release is instantaneous.

This brake has been in operation on several cars running on the Chicago City Ry. Co.'s lines for six months, and has proved so successful that it will be placed on many other cars during the winter. One of its principal advantages is the reduced physical labor required of the motorman in braking, and the reduced mental strain since he has much less fear of accidents. It is also expected to reduce the number of "slid-flat" wheels.

## THE BATES THERMIC ENGINE CO.

Public announcement was made in the Philadelphia daily papers about Oct. 1, of the great success of a wonderful new engine, which, it was claimed, would save 80% of the fuel consumed by ordinary steam engines, and invitations were given to the public to see the engine in operation at No. 1040 Ridge Ave. The Bates Thermic Engine Co., 652 Philadelphia Bourse, at about the same time issued a pamphlet advertising the engine, and a circular "Prospectus," headed "A Revolution in Motive Power," "Consumption of Coal 80% less than with Steam Engines," etc. According to this prospectus the company is chartered under the laws of West Virginia; capital stock, $5,000,000; shares, 100,000 at $50 each, of which 15,000 shares are now offered for sale at $10 per share. The company owns the exclusive rights to manufacture, use and sell the Thermic engines in the State of Pennsylvania, in the State of Delaware, and in the State of New Jersey, south and including Trenton. The officers of the company are Russell Thayer, President; A. E. Kennelly, vice-president; Wm. J. Elliott, secretary and treasurer. The directors are James McManes, Edwin J. Houston, Allen B. Rorke, Henry Clay, David S. B. Chew and Geo. H. Holgate. Some of these names are well known to engineers. Mr. Thayer is a Member of the American Society of Civil Engineers and is Chief Engineer and Superintendent of Fairmount Park. Mr. A. E. Kennelly is an Associate Member of the American Institute of Electrical Engineers and one of the managers of that society. Prof. E. J. Houston is a Member and Past-President of the American Institute of Electrical Engineers, and is a scientist and an authority on electrical subjects whose fame is world-wide.

Certainly the fact that engineers of such eminence are the managing officers of a new engineering enterprise ought to be a good guarantee of its soundness from an engineering standpoint, and should therefore strongly recommend it to investors. We often hear of inventions which are to generate power with a fraction of the fuel used by the steam engine; but it is seldom that any of these new inventions are vouched for by such an array of names as that above noted.

With this in mind, we deemed it well worth while to undertake an investigation of the new motor, for which such large claims were made, and a member of the staff of this journal visited Philadelphia, examined the engine in operation and secured all the information available concerning the new motor and the company formed to exploit it.

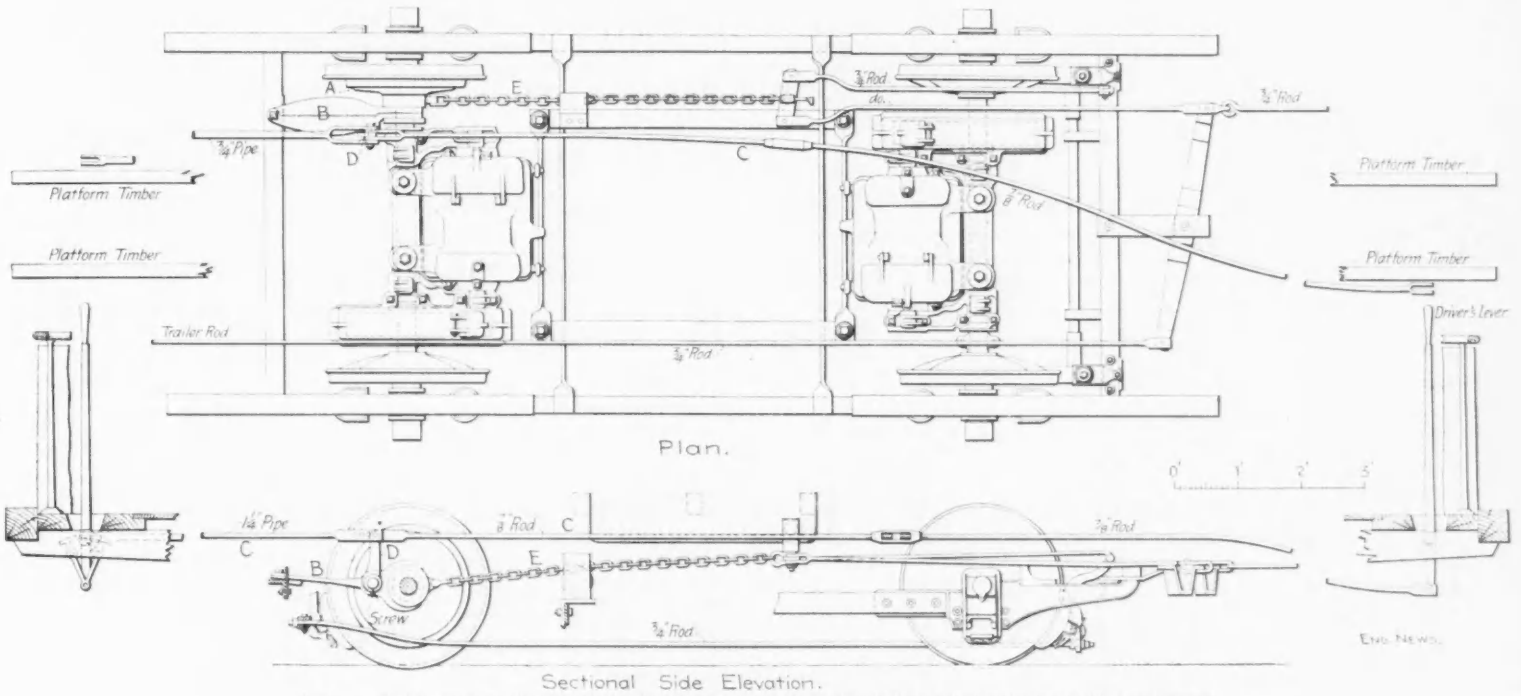



FIG. 1.—PLAN AND ELEVATION OF ELECTRIC CAR TRUCK WITH MOMENTUM BRAKE ATTACHED.
Used by Chicago City Ry. Co. Designed by Wm. G. Price.

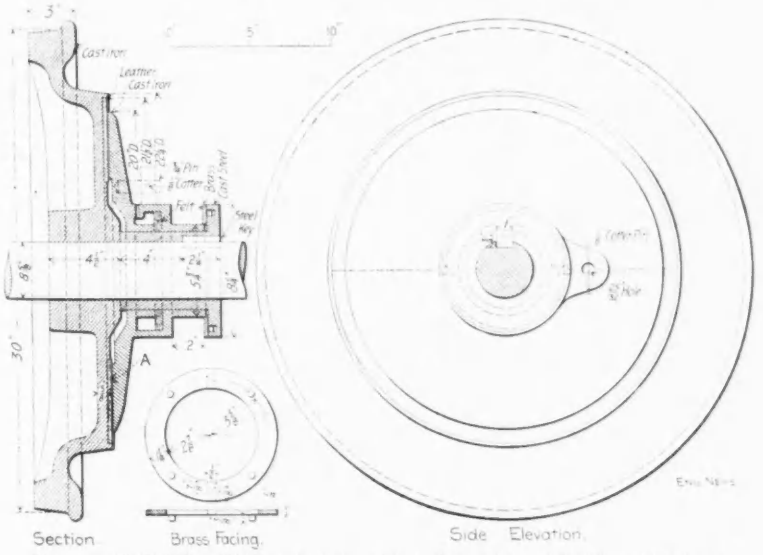



FIG. 2.—SECTIONS THROUGH CAR AXLE SHOWING FRICTION CLUTCH OF MOMENTUM BRAKE.

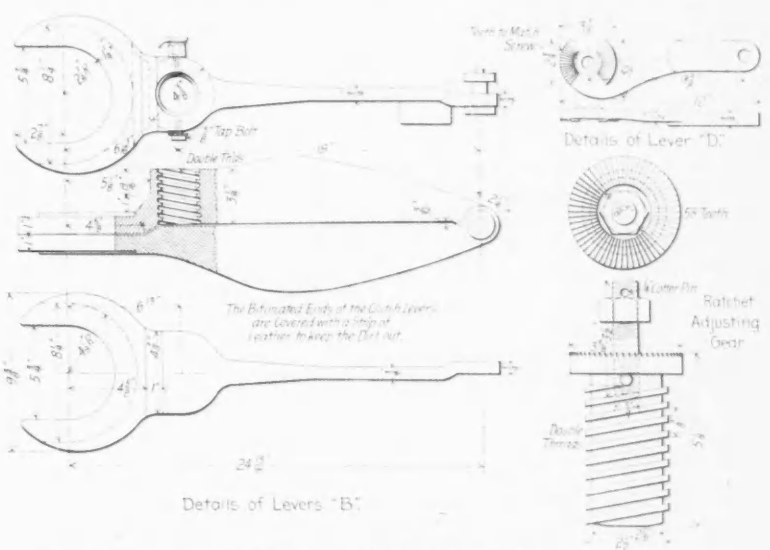



FIG. 3.—DETAILS OF FORK OPERATING CLUTCH OF MOMENTUM CAR BRAKE.

According to the pamphlet issued by the company, the history of the motor is given as follows:

M. Gardie, of Nantes, France, patented a gas engine in 1889, and assigned his patent to the "Societie Anonyme des Moteurs Thermiques Gardie." After M. Gardie's death, experiments were continued by the society for five years, under the direction of Maurice Lorois, who succeeded in perfecting the system, and patented the present engine in 1894. The Bates Thermic Engine Co., of Philadelphia, was organized, and purchased the exclusive rights under these patents for the states of Pennsylvania, Delaware and part of New Jersey, as above noted. It then made patterns from the original drawings furnished by the French company. The engine was then built by Mr. A. Falkenau, whose machine shop is at 11th St. and Ridge Ave., Philadelphia, in the basement of which the engine is now running.

We have secured from the patent office copies of the U. S. patents of M. Lorois, of which one is for a process of manufacturing gas, No. 529,453, and the other for a gas motor, No. 529,452, both dated Nov. 20, 1894. The latter patent gives a very complete description of the engine and its operation, from which we condense the following: Fig. 1 is a diagrammatic view of the engine with its appurtenances, and Fig. 2 is a front view, partly in section, of the engine.

An air pump or compressor P compresses atmospheric air to a pressure of 43 lbs. per sq. in. and upwards, into an air reservoir Z, where the water is separated from the compressed air. The compressed air passes from this reservoir through a pipe and branch pipes and into two heat interchangers or regenerators R R', in which it is heated by the spent gases of combustion exhausted from the power cylinders C C of the engine. The heated compressed air passes from the interchanger R' by a pipe x to the gas producer G, constructed as a cupola furnace. At the same time superheated steam is introduced to this producer as hereinafter explained, and commingling with the air flows through a mass of incandescent fuel in the producer, whereby is generated the combustible gas. This gas, being produced under the same pressure as that initially given by the air pump, passes out from the producer by a pipe and enters a dust separator N, which disengages any dust or ashes from the gas and then flows through the pipe Q' to the inlet ports of the power cylinders C C. The compressed air which is heated in the interchanger R passes therefrom by a pipe which has branches leading to the air inlet ports of the power cylinders.

The operation of the engine is as follows: On the opening of the inlet valves the heated compressed air and hot compressed gas which until now have been separate, and which are both at the initial pressure given them by the pump P, flow in suitably regulated proportions into the cylinder, entering it at the commencement of the stroke of the piston and being ignited by contact with the walls of the cylinder and piston, which thus serve as the igniter. The gas and air being mixed in the proportion necessary to complete combustion, burn in the cylinder. The gases continue to enter while the piston moves through a portion of its stroke and up to the instant when the inlet valves are closed. Up to this time the pressure continues the same as the initial pressure given by the compressor, and which is maintained in the gas producer and all the apparatus. From this moment the expansion of the gases commences, and as the piston recedes the pressure falls, while in acting against the piston the gases develop mechanical energy, and in consequence undergo a considerable reduction in temperature. At the end of the working stroke of the piston the exhaust valve is opened, and during the return stroke the products of combustion are expelled from the cylinder and ultimately escape into the atmosphere. The pistons of the two cylinders work alternately, each developing power on its working stroke, and being driven by the other on its return stroke. The hot spent gases of combustion expelled from the respective cylinders are conducted through pipes to the two heat interchangers R and R', through which the flow, giving up their heat to the compressed air which is flowing oppositely through these interchangers, and the spent gases being finally discharged through a pipe into the atmosphere, producing neither noise or smoke, and having given up nearly all of their heat. At the same time water is forced by a pump p, through a pipe t'', which divides into two branches, conducting the water into jackets h' surrounding the lower portions of the power cylinders, from which jackets the water passes by pipes t''' into jackets h surrounding the upper portions of the cylinders, these upper jackets constituting steam generators wherein by the heat disengaged in the cylinders the water first heated in the lower jackets is converted into steam, and the steam flows through a pipe s' to the gas producer, wherein the pipe is formed into a coil or superheater s exposed to the intense heat of the newly generated gas, whereby the steam is highly superheated, after which it is conducted through a passage s' down through the heated brick work or lining of the producer, and commingled at the lower part thereof with the heated compressed air introduced through the pipe x.

The gas producer G is constructed to resist pressure. It has a strong outer casing or jacket of sheet steel, within which is built a fire-brick lining. It is provided with a feeding hopper on top having a tight closing lid and a delivery valve. By closing the valve and opening the lid, the hopper can be filled with fuel, whereupon by tightly closing the lid and opening the valve this fuel falls into the producer.

The operation of the gas producer under pressure in connection with the pre-heating of the air, and the superheating of the steam, enables a much higher temperature to be maintained in the gas producer than has ever been possible heretofore. The result is to furnish a gas having a high calorific power, and completely free from tar and ammonia.

A partial combustion occurs in the gas producer which is sufficient to maintain it at the high interior temperature required. The gas being free from all impurities which would necessitate the use of condensers and purifiers, permits complete suppression of such purifying apparatus with their attendant necessity of cooling the gas. The rate of production of the gas can be varied from time to time in accordance with the varying requirements of the engine, so as to allow of the complete suppression of a gasometer between the gas producer and the engine. As the fuel in the gas producer is consumed it settles to the bottom and the resulting ashes or slags may be removed from time to time through an orifice by opening a tightly closed lid or door.

The dust separator N has a strong outer shell which is protected by a refractory non-conducting lining as shown.

The heat interchangers RR' are each constructed with an upright cylinder of sheet metal, having at top and bottom two cast domes, between which are extended numerous tubes fixed at their ends in two metallic tube sheets. The whole construction is surrounded by an independent cast jacket.

The two motor cylinders C are alike, each being single-acting. Each cylinder is divided into two parts, the upper or hotter section being made larger than the piston or plunger, while the lower or cooler section is made to fit with the piston. The upper section is provided with a non-conducting substance, and with a plate i of a suitable heat-retaining metal adapted to maintain a sufficiently high temperature for automatically igniting the gases. The piston is of considerable height, its lower part which never leaves the cooled lower section of the cylinder being provided with packing rings K. For lubricating the cylinder, oil is contained in a collar l, into which the lower flange of the piston dips. The lubrication of the piston is made possible since the temperature of the lower portion of the cylinder does not reach 60° C. The lower section of the cylinder is cooled by the circulation of cold water in the jacket h'.

The top of the piston P' is also provided with a plate i' of a suitable heat retaining metal insulated by asbestos. Nickel is a suitable metal for the plates i and i'. As the plates are always red hot, the combustible gas and heated air introduced through the gas and air inlet ports, mixing in the cylinder in contact with these plates, is ignited and burns without explosion while being introduced, remaining at the initial pressure of 3 kilos. per sq. cm. or upward (this pressure once determined upon remaining constant).

The diagrammatic view of Fig. 1 is a very fair representation of the system used in the engine as installed in Philadelphia. The arrangement of the parts, however, is somewhat different, thus the two heat interchangers are located so as to adjoin the two power cylinders, and the ground plan of the whole is arranged so that all the apparatus is contained inside of a floor area about 16 ft. square. The cylinders of the Philadelphia engine are each 15¾ ins. diameter and 15¾ ins. stroke.

The engine being constructed as above described, the next question likely to be asked is, what results have been obtained from it? To answer this we have recourse to the pamphlet issued by the company. It contains a report by Mr. Thomas Pray, Jr., who adds to his name the initials C. C. and M. E. These letters, we understand, do not mean that Mr. Pray is a graduate of any engineering school or a member of any society of engineers, as some readers may imagine, but they are simply an abbreviation of the words "Consulting, Constructing and Mechanical Engineer," which appear at the top of his report. Mr. Pray's report is a literary as well as an engineering curiosity, as will be seen by the extracts which we quote from it below. It is not remarkable for its brevity, covering some 28 duodecimo pages, and we have even had some difficulty in finding out from the report what economy the engine actually showed under his test. On this subject, in fact, Mr. Pray makes a charming variety of statements, some of which we quote "verbatim et literatim," as follows:

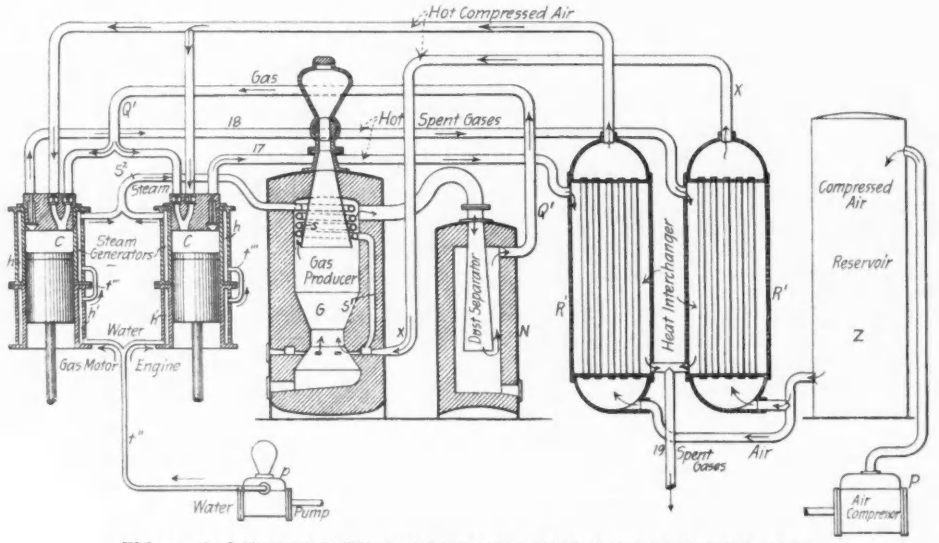



FIG. 1.—GAS ENGINE WITH GAS PRODUCER WORKING UNDER PRESSURE.
Patented by M. Lorois, Nov. 20, 1894.

P. 5. Your engine burns less than 1 lb. of coal per I. HP., and when delivering 100 HP. at its belt will consume less than 1.2 lbs. per HP. per hour from the data of present actual tests made.

P. 9. Economy of fuel consumption for large marine engine.—This engine in large powers can undoubtedly produce its indicated HP. at less than 0.9 lb. of coal, including the power for air compressors, and the required auxiliary steam.

P. 14. When the engine is in full motion doing 81.9 HP., not varying two revolutions per minute and the load running from the one just mentioned to 82.9, we have to put a hod of poor quality of PEA size coal into the gascogen once in 24 minutes.

P. 19. The coal now in use is a "pea size anthracite," costing in the coal bin, $3.75 per ton, and from picking it contains 2 lbs. 5 oz. of slate in a hod of 28 lbs., or 8.3% of refuse before it goes into the gascogen for use, or we buy 91.69% of real coal, and 8.3% of waste, and from this coal the past week we find that with an indicated horsepower of slightly more than 82, that in regular operation it calls for .85367 lbs. of coal for 1 I. HP., one hour, not making any consideration of the loss of over 8% of the coal in worthless slate, but which is paid for and counted as used; if we figure the performance of the engine as we do that of the steam engine, by allowing the refuse of the coal, the result will be changed to in the last amount of .78319 lbs. of coal for 1 HP. for one hour.

The amounts stated above are from the total load of the engine as it was running yesterday, September 4th, but as it is intended to not consider the air compressor as "power" and it is intended to consider the engine as indicating about 140 HP. in order to take off 100 HP. from a belt, I have estimated that "as intended" taking the actual load as above, and the results stated as actual, with a "commercial result" of taking the first actual amount of .85367 lbs. for one hour of 1 HP. and suppose your engine does its work only as efficiently as it has in the four days of this week, and your slate is as good as COAL, and 40 HP. is actually done in compressed air, and the coal is counted to do that 40 HP. but in your figuring you say the 40 HP. is not power, and call your load 100 HP. then your engine would use in one hour 119.52 lbs. of coal, which was actually 8.3104% slate, it would indicate 140 HP., but you don't credit it as power only for 100 HP., as all you get on a belt, and all this would cost you 119.52 lbs. coal.

PERHAPS SOME OF YOUR BOARD KNOW OF STEAM ENGINES DOING THAT? I DON'T; and now as we are in a speculative mood we go one step farther, and take

out the slate, and call the 40 HP., not commercial, actually indicate 140 HP., but only figure 100 as transmitted to your machinery, and we shall have for THAT train of conditions, the using up of 109.64 lbs. of coal each hour to furnish you "business men" with 100 HP. to run your looms, or spindles, electric cars, or any other purpose you may choose, and as you are figuring now, you get 100 HP., 109.64 lbs. of coal, with NO slate in it, and still get your air pumped for nothing with which to make gas.

Now, in either case you will give me credit for not deducting anything for ashes, or for moisture in the coal, and the basis I have taken is that your engine has only 58% of its rated load, and you are almost at ONE pound of poor coal for 1 HP. one hour.

The above extracts give fair examples of Mr. Pray's lucid literary style, and from them we glean after considerable study that the engine has actually given one indicated horse-power for 1 lb. of coal, that it may be expected to give a brake horse-power for 1.2 lbs., and that it is believed it will show still better economy when built in larger sizes than 100 HP. An engineer reading these figures would naturally inquire, How much better is this result than the results obtained from other gas engines? Mr. Pray, C. C. and M. E., makes no attempt to answer this question in his report, but instead flourishes a comparison between the Lorois gas engine and the steam engine. The pamphlet issued by the Bates Thermic Engine Co. opens with an extract from a lecture delivered by Mr. Pray before the Franklin Institute in 1889, from which we quote as follows:

In the ordinary form of steam engines the expenditure of 5 to 8 lbs. of coal per horse-power per hour is not considered excessive, and with the latest improved type of quadruple compound condensing stationary engines, the best results show that from 2 to 3 lbs. of coal are necessarily consumed in the production of a horse-power per hour.

With all due respect to Mr. Thos. Pray, Jr., C. C. and M. E., it must be said that a fuel consumption of 5 to 8 lbs. per horse-power hour in a steam engine is considered excessive, and that instead of a quadruple engine "necessarily" consuming 2 to 3 lbs., such engines have given on test a consumption of less than 1.4 lbs. But in any fair study of the possibilities of any new form of gas engine accomplishing a "revolution in motive power," its fuel consumption should be compared not with that of such a poor variety of steam engines that "a saving of 80% of fuel" can be shown by the comparison, but with the results which have already been obtained with other gas engines which have been on the market for years. In order to show what actual saving, if any, the Lorois engine, with its consumption of 1 lb. per 1 HP. hour and 1.2 lbs. per B. HP. hour, makes as compared with other gas engines, we quote the following from the 2d edition (1896) of Mr. Bryan Donkin's recent work on "Gas, Oil and Air Engines:"

In the Otto-Crossley gas engine, using Dowson gas, the consumption of anthracite is from 1.0 to 1.4 lbs. per I. HP. per hour, or of coke 1.5 lbs. (Donkin, p. 91).

In 1891 a test of an Atkinson gas engine at the Uxbridge Water Works, with Dowson gas, gave 21.95 I. HP., and the consumption of anthracite was 1.06 lbs. per I. HP. per hour (p. 106).

In 1895 a 65-HP. Stockport gas engine, near Tonbridge, with Dowson gas gave a result of 0.93 lb. fuel per I. HP. hour or 1.6 lbs. per B. HP. hour. Another test on an engine driven by Dowson gas at Portadown gave 44.6 I. HP., the consumption of best Welsh anthracite being 0.91 lb. per I. HP. hour (p. 119).

At Schwabing, near Munich, a 40 B. HP. Otto engine, worked with Dowson gas made from German anthracite gave a consumption of 1.54 lbs. per B. HP. hour (p. 120).

One of the latest types of Tangye engine is a single cylinder engine of 24. ins. diam. and 30 ins. stroke, driven by Dowson gas, with a consumption of 0.8 lb. Welsh anthracite per I. HP. hour (p. 122).

A simplex gas engine of 81 B. HP. tested at Aubervilliers, in France, in Nov., 1894, using the Lencauchez gas generator showed a consumption of 1.10 lbs. of Anzin coal per I. HP. hour, and 1.45 lbs. per B. HP. hour. Another simplex engine of 220 B. HP. at Pantin, France, tested in Feb., 1894, showed a consumption of 0.80 lb. Anzin coal per I. HP. hour and 1.02 lbs. per B. HP. hour (p. 483.)

A Schleicher-Schumm Otto gas engine, tested by Prof. Spangler, of the University of Pennsylvania, in 1892, using the Taylor gas producer, gave 92.5 B. HP. with a coal consumption of 0.94 lb. per I. HP., and 1.30 lbs. per B. HP. hour. (Jour. Franklin Institute, May, 1893.)

It will be seen that the test last quoted was made in Philadelphia four years ago, on an engine built in Philadelphia, and it gave a result nearly the same as that now given by the Lorois engine: and yet the Otto engine has not yet proved itself a "revolution in motive power" to such an extent as to seriously interfere with the market for steam engines.

The Gardie engine (of which the Lorois engine is a later form) is referred to on p. 162 of Mr. Donkin's book as below; the Lorois engine does not appear to be mentioned:

One of the latest developments in gas engines is the introduction of motors having gazogenes attached, in which generator or power gas is made per stroke and passes direct to the engine, without intermediate storage in a gas holder. Two forms of this apparatus have lately appeared in France, the Gardie and the Benier; the former seems to be still in the experimental stage. * * * *

In the Benier engine the gas is produced automatically per stroke as required, by the suction of the motor piston; thus its quality is said to be always uniform, and being generated below atmospheric pressure, loss by leakage is avoided. As the gas is only at atmospheric pressure a pump is required to mix it with air and deliver it to the engine.

From an examination of Mr. Lorois's patent it appears that the essential difference between his and the Benier engine is the manufacture of gas in the Lorois system under high pressure, 43 lbs. per sq. in. or above. The only advantage which this method can have, apparently, is the superiority of the quality of the gas made under pressure, which is claimed by M. Lorois. The power to compress the gas and the air is exerted by a separate air compressor, while in gas engines using the Otto cycle the power is exerted in the cylinder of the engine itself during the "compression stroke." There does not seem to be any important difference as far as the power required for compression is concerned, whether

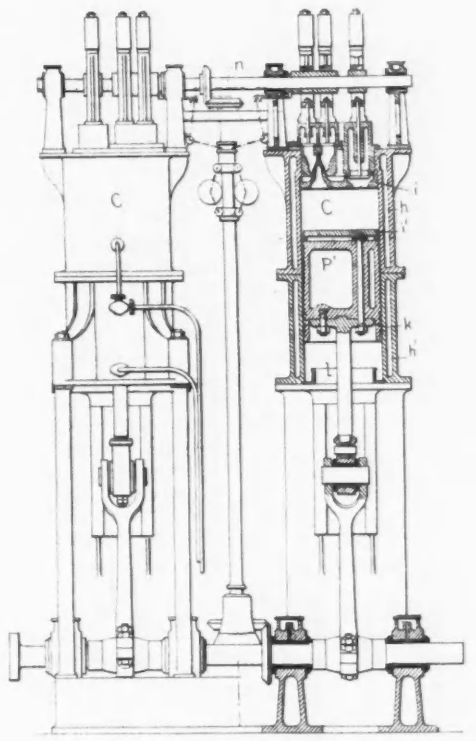


Fig. 2.—The Lorois Gas Engine, Front View.

it is exerted in the engine cylinder or in the compressor cylinder. The difference, if any, in the quality of the gas, in favor of the Lorois method does not give any direct advantage in fuel economy, its sole advantage consisting in the alleged freedom from tarry matters liable to deposit in the cylinder and valves of the engine, and the consequent suppression of the scrubbers and washers which are used in connection with the gas producers of ordinary gas engines. To offset this advantage the whole plant, including air receiver, heat interchangers, gas producer and dust catcher, together with the piping system, has to be built of sufficient strength to resist with abundant safety the pressure which exists throughout the plant, 70 lbs. in the engine at Philadelphia. This necessitates a somewhat expensive construction.

Mr. Pray discusses a number of other features of the engine, besides its fuel consumption. His following remarks concerning the operation are interesting:

To start the engine a small auxiliary steam boiler is required, for a short time, and so far as possible for me to say, an 8-HP. boiler would handle this 100-HP. engine, and furnish the steam required until the engine had its own steam. it is also necessary to have a dynamo of about ¾-HP. output to run the firing wire until the plates are hot, and the dynamo in use, is used for from 55 to 70 minutes, according to pressure and load, when it is "cut out of circuit" and is of no further use until the engine is cold; this is also true of the auxiliary air compressor, a small one outside of the engine is needed, for charging to start with, but when running, if any accident to belts or machinery occurs necessitating a stop, there is no difficulty with ordinary care, in holding the pressure for some hours, and starting on as easily and with the same certainty as with half a dozen steam boilers with "steam up," for, if the air connections are tight, they will hold for ten hours or more, pressure sufficient to go on and re-heat the whole, which requires ten to twelve minutes (at proper pressure), and in that time the whole load can be taken on and run with no waiting for "steam" or pressure.

When running, the proportions of air to the gascogen, and of steam, can be easily and certainly known, with the same care used or needed in operating a steam plant, but with no such waiting for "steam to get up" the fire requires constant feeding, not continual, but at stated intervals, and if it is allowed to get low and is still in the possibilities to keep at speed, you can add one or two hods (we feed 28 lbs. at a time in coal hod)—and in three minutes you can get on full, then add at stated intervals as already stated (28 lbs. in 24 minutes keeps nearly a 100-HP. going), with a surplus at the end of the day. And in its full load and speed, it will compare with the best built steam engines very favorably, as to care and the amount of work to be done on it, but it is not a machine that will run without care and attention, or by a careless man in its charge, nor will it do to put ignorant men, or cheap ones who know nothing and care less, into the care or charge of such a high speed sensitive machine, using such heat, but with the men who delight in fine running machines, ease, certainty, and fullest control this motor will be more than welcome; it cannot be blown up, unless by criminal intention, and I do not know now how it would be possible to do that; there is not a trace of smell from the gas, and a person visiting the machine cannot tell whether it is run by one or the other force, from any smell which is perceptible in or about the room where it is.

When the gas does escape, it has a smell once experienced, not forgotten, hence it is not insidious, and is so apparent that if it was poisonous it could not endanger human life, but when smelled it gives in a few moments a feeling as though a hearty dinner had been eaten, and in about six hours a most peculiar headache, in front, above and through the temples, and this is about twelve hours in leaving, after which no "after effects" are perceptible.

Mr. Pray concludes his report as follows:

YOUR ENGINE IS THE NEAREST APPROACH TO THE DREAM OF SCIENTIFIC MEN OF MANY YEARS, BY WHICH THE ENERGY IN COAL WAS TO BE DIRECTLY APPLIED TO THE PRODUCTION OF POWER. I do not imagine that your board appreciate the value of what you have in your hands, in a strict business way. The engine has been sensitive to changes, and has in every point responded to adjustment, and shown its capacity for hard work, its beautiful regulation, and its great efficiency, ease of management, and if it is put into proper hands for future development, and conducted on lines intended, it will be the fault of whoever has it in charge, it is NOT one of the most successful business ventures attempted in the line of "prime movers."

I have become more and more pleased with the splendid ability of the inventor, and the persistent patience of his French nature in putting his ideas into iron and steel for the benefit of the human race.

Our own opinion of the engine, after examining the engine itself and carefully reading M. Lorois's patents and Mr. Pray's report, is that it is a gas engine which may some day, at considerable expense, be developed into an engine which will be a commercial rival of the Otto and the numerous other gas engines that are now on the market. Its method of saving heat by means of the regenerators or heat interchangers, is not new, and they may be applied to engines of the Otto type whenever the saving of heat made by them is found to justify their cost. Whether the advantage of the manufacture of a gas which requires no washing or scrubbing, which is claimed for the Lorois system is sufficient to compensate for the increased cost of apparatus, which the production of gas under pressure makes necessary, is a question which can only be answered after long experience in practical work.

The machine embodies some interesting departures from ordinary gas engine practice, such as the igniting of the charge by the hot interior of the cylinder; but the figures of Mr. Pray's test do not show that the net results of these departures is to make the machine generate power with any less fuel consumption than is attained by other gas engines now on the market.

Perhaps when the apparatus has been further developed and perfected, better results will be shown; but after a careful perusal of Mr. Pray's report we are constrained to believe that he has said everything favorable that can be said concerning the machine in its present condition.

In view of all these facts we can see no shadow of justification for the capitalization at $5,000,000 of a company which owns not even the patents on this motor, but merely the rights for two states and part of another under patents of unknown value and has, so far as we can learn from its own published statements, no other property whatever. The capitalization of the enterprise and the valuation at which it is offering its shares appear to us to be about as exaggerated as are the rhetorical flights of Mr. Pray's report. Some other aspects of the subject we have discussed in our editorial columns.

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According to items from the daily press now in circulation the timber dry-docks lately built at our various government navy yards are being seriously damaged by marine worms. The Bureau of Yards and Docks of the U. S. Navy Department is also credited with being inclined to favor the construction of stone docks hereafter, as being in the end more durable and economical notwithstanding their first heavy cost. This news would be important, if true; but inquiry made of the proper sources of information leads to a very different conclusion. Timber dry-docks have now been in use in the United States for over 30 years, and somewhat longer than that in England. Official inspection of the older docks in this country shows that the timber in the interior is unaffected by the teredo-navalis, as this part of the structure is empty much of the time, and it is impossible for the worm to do any considerable damage in the short working time at its disposal. But the teredo does attack the dock entrance, and the outer parts of the caisson abutments, and when made of timber these must be renewed from time to time. It is for this reason that the Puget Sound dry-dock, the latest one completed by the U. S. government, is provided with a concrete abutment lined with cut masonry, and the approach wing walls are also of concrete faced with stone. As to the general durability of timber dry-docks it is found that the timbers in the oldest one in this country are practically intact and exhibit no decay except upon a very thin outer shell. The timbers in the upper part of the dock proper, above mid-tide mark, do deteriorate in time, but these can be readily renewed at a comparatively small cost. As this part of the dock could easily be constructed of concrete, by cutting off the piles at low tide mark and capping them, it seems strange that this is not done in our government docks, especially at Puget Sound, where concrete was extensively used for purposes of protection. It is clearly demonstrated by expert examination and by actual experience with these docks for more than 30 years, that timber dry-docks are not only comparatively very cheap to construct and generally durable, but that with a little additional expense they can be protected efficiently against their worst enemy, the teredo-navalis.

When it comes to a question of comparativ cost, between stone and timber docks, the advantage is decidedly with the latter. The Mare Island stone dry-dock, at San Francisco, is 513 ft. long and 79 feet wide and is said to have cost about $4,000,000 to build. The Puget Sound timber dry-dock is 650 ft. long by 97 ft. wide and cost $607,951, or less than one-sixth of the cost of the stone dock. But the timber dock is not only vastly cheaper, but is vastly more convenient for working upon the hull of a ship. There is really no comparison between the modern wide-flaring, well-lighted and roomy timber dock and the steep side walls of the average stone dock. The Mare Island dock, in this respect, compares more nearly with the timber dock, as it has a much flatter slope and is wider in proportion than any of its stone predecessors; but to build a stone dock on the generous proportions of the later timber docks would make the cost prohibitory. If the interest on the cost of the Mare Island dock is taken at 4 per cent. it will be found that this accumulated interest would build a timber dock of the Puget Sound type about every five years, even assuming that the cost of the latter was increased by a sum sufficient to replace with concrete the whole upper part of that dock now exposed to gradual decay. And this estimate does not take into consideration the fact that the timber dock was completed in 43½ months as compared with the ten or eleven years consumed in the construction of the Mare Island stone dry-dock. In view of these considerations it is not at all probable that the government engineers propose to return to the old stone type of dry-dock construction.

The review of the prospectus of the Lorois gas engine, on another page in this issue, will prove interesting reading to those who are watching the progress of the gas engine in its rivalry with the steam engine for use in electric lighting and power plants. The fact that gas engines are capable of furnishing power at a fuel cost of but little over 1 lb. per brake horse-power hour, while few steam engines, even of the most expensive types, have shown a better record than 1½ lbs., should induce engineers who have anything to do with the installation of new electric plants to give the gas engine careful attention. The probability of the gas engine supplanting the steam engine to any serious extent, however, seems at present remote. Fuel economy is not the only thing to be considered in the selection of motive power, and the disadvantages of gas engines in other respects, such as high first cost, difficulty of keeping in order, expense of operating gas producers etc., which have hitherto kept the gas engine from being a dangerous rival of the steam engine, are likely for some years to come to delay its progress.

In this connection a recent experience with gas engines at Aurora, Ill., is of interest. The gas company desiring to supply electricity as well as gas light to its customers, bought a number of dynamos and had them set up in the engineroom of the Aurora Street Ry. Co., which company ran them by belt from its steam engines. The gas company, thinking it could run its dynamos more cheaply by gas engines than by rented steam power, purchased under guarantee a number of gas engines and removed the dynamos from the railway company's power-house to its own. After about two weeks' trial, the gas engines were condemned, and returned to their builder, the dynamos were set up again in the street railway power-house, and the gas company is now planning to buy boilers and engines and run its dynamos by steam in its own gas works.

The common method of power transmission on board naval vessels is by steam pipes, extending from the main boilers to the various engines, and the great variety of machinery which is necessary on a modern battleship makes a great amount of steam piping necessary. This piping is objectionable for many reasons. It is bulky and takes up valuable space, when protected as it must be with non-conducting covering. The covering is subject to more or less deterioration with the vibration of the ship and the machinery. The heat from the pipes is objectionable in every closed space. The necessity of providing for the exhaust and of keeping the pipes drained of condensation is a constant source of trouble. But more than all else is the danger which exists in every such steam pipe in time of action. The cutting of any one of them by a projectile means the escape of high-pressure steam, involving in a horrible death every one within its reach.

At the International Congress of Naval Engineers at Chicago in 1893, Mr. George W. Dickie, of the Union Iron Works, of San Francisco, advocated a system of hydraulic power transmission for use on ship-board, with large pressure pumps in the engine room and Pelton wheels, hydraulic rams, etc., to perform the work of dynamo driving, hoisting, etc. The system certainly possesses many advantages over the steam distribution system, especially with respect to its freedom from danger; but the equipment which has been installed on the U. S. monitor "Terror" seems to even surpass it in efficiency. On this vessel, as described in a news note in this issue, compressed air is used for performing all the various mechanical operations on board, from moving the rudder to hoisting ammunition. That this is far superior to a system of steam pipe distribution or to the scattering of donkey boilers over various parts of the vessel, will be apparent. The only system that promises to be able to at all compete with it is electrical power distribution. It would appear that compressed air would be superior to this in simplicity for direct hoisting, while where a rotary motion is wanted the electric motor would have the advantage.

That one or the other of these systems, or perhaps both combined, are bound to displace the dangerous steam pipes wherever shot and shell can come, seems certain. If two vessels were to engage in such a naval duel as that of the "Kearsarge" and the "Alabama" for example, one equipped with steam pipes and the other with electric or compresed air transmission, it would take a great deal of superiority in armor and armament in the former to make its chances of success in the contest equal.

In these days of improvements, real and alleged, those in charge of both public and private undertakings have a host of devices presented to them for examination. The advocates of these devices do not always have an opportunity to set forth the reasons for their adoption, and even when they do, the claims urged are often speedily driven from the minds of those to whom they are presented by a multiplicity of cares. If a fairly good article of a certain class is in service there is a natural tendency to continue it in use, without giving much attention to alleged improvements, urged in the ordinary manner. Numerous changes in standards are often disadvantageous, although in some lines it matters little whether a new article is like those of the same class previously used, the main object being to have the best, regardless of previous custom. In the course of a few years, often in a very few, important improvements are sure to be made in almost every line. On this account a general survey of the field is desirable now and then. Such a course gives ample opportunity for comparing various devices and settling upon the best in a truly critical manner, instead of relying upon impressions gained from time to time in a few hasty moments, and perhaps due quite as much to the suavity of a skillful agent as the merits of the device. A careful examination of one class of appliances is about to be made by the New York Department of Public Works, as noted in our news columns last week. Valves, hydrants and accessories are to be considered with care, first through the literature put forth by manufacturers and next through an exhibition, to be held Nov. 10, at the Corporation Yards, 437 East 24th St., which yards are in charge of Mr. A. G. Gear. All communications on the subject should be addressed to Gen. Chas. H. T. Collis, Commissioner of Public Works, 150 Nassau St., New York city.

The separation by means of magnetic machines of materials which have hitherto been considered non-magnetic, which is described in the paper of Messrs. Wilkens and Nitze, elsewhere in this issue, is the latest novelty in metallurgical processes, and one that may some day prove to be of

great importance to owners of deposits of low grade hematite iron ores. There are vast bodies of such ores in certain districts of this country which are now entirely valueless by reason of the availability of low-priced better ores in their vicinity. In other places high grade and low grade ores are found in the same mine, and the latter are now left in the ground or thrown away on the waste dump. If they can be concentrated by the new magnetic machines at reasonable cost, a notable benefit to the iron trade will result, in the securing to it a new and large supply of cheap ores.

## ENGINEERS AND SPECULATIVE ENTERPRISES.

In the "Code of Ethics," which has been adopted by the Canadian Society of Civil Engineers and was printed in our issue of Feb. 13, 1896, occurs the following:

> The Civil Engineer should avoid connecting himself with schemes or projects of a merely speculative character, always bearing in mind that his professional reputation will be to a great extent judged by the inherent merits and commercial value of the undertakings with which his name may come to be associated.

If this code of ethics be considered as nothing more than a statement of general principles, which one may accept or reject as he pleases, it will yet be agreed, we believe, that no more sound and wholesome advice could be given to an engineer than is conveyed in the above.

The commonest question which is ever asked concerning an engineer is, "What work has he been connected with?" People in general judge an engineer not by his stores of knowledge, or his executive ability; not even by his professional work, so much as by the character and the success of the enterprises with which his name comes to be associated. We are speaking now, of course, not of subordinate positions, but of the engineers in responsible charge of work. No one will deny that this standard is often an unjust one. Because the financial management of an enterprise causes its ruin is really no reason why injury should be done to the reputation of the engineer, who very likely did hard and faithful work all through. But be the standard just or unjust, it is the standard which people in general accept, and the fact is one which every engineer will do well to bear in mind.

It will, of course, be understood that we are not speaking now of the reverses which may come to any buisness enterprise, though these to some extent fall under the same rule, but rather of the enterprises "of a speculative character," as the code of ethics above quoted describes them. Concerning new enterprises the code says:

> The Civil Engineer whose advice is sought in respect to the usefulness, practicability and cost of a work should, before expressing his opinion, obtain reliable information on all points involved in the matter submitted to his judgment, including the probable paying capacity of the contemplated undertaking.

No one, we presume, will question that the term "Civil Engineer" in the above quotation should be given its broadest meaning, and that the rule of conduct is applicable equally to engineers in all branches of the profession. Let us express the same thing in somewhat different words: The engineer sells advice. He is subject then to the same rules that govern all trade. If he sells good, safe and sound advice, the demand for his services will continue. But if he gives bad advice in return for his fee, either through ignorance or because he wishes to say what will please his client, he will soon find that no one wants to buy advice of that sort. Even the clients who want an engineer who will twist his report to further their ends without regard to the truth, will pass him by because they know that his word carries no weight with the investing public.

These things are not fancy or mere theory by any means. We have in mind, as we write, concrete instances. In one case an engineer's name was used in connection with a concern against which a "fraud order" has been issued recently by the Post Office Department through the efforts of this journal. It need hardly be said that nothing can ever efface the injury done to that engineer's professional reputation by that connection. Another engineer has become noted for his connection with schemes of a highly speculative character. His reports upon them, designed to attract investors, are marvels of ingenuity; but he has become so well known in this field that the mere fact of his connection with an enterprise is sufficient to make one look upon it with suspicion.

If the engineer whose ignorance or dishonesty leads him into such a course injured only himself and those who are foolish enough to rely on his opinions, his misdeeds would be of comparatively little interest to the profession at large. The punishment would fall where it was deserved. But this unfortunately is not the case. The engineer who gives bad advice or whose work fails always brings discredit upon the profession, just as surely as the engineer who succeeds in a great work raises the profession in the public estimation. And the injury done to the profession by an unworthy member is tenfold greater where it is the honesty and not merely the engineering ability that is at fault.

But it will be said that it is unfair to hold the profession at large responsible for the acts of individual members. Any one, no matter what his qualifications or lack of qualifications, may call himself an engineer and may sell engineering advice—if he can find purchasers for it. This is, of course, true; and yet, we believe that in this matter, the public is not quite so ignorant as is sometimes thought. People do understand, we believe, the difference between the engineer of character, reputation and high standing in the profession, and the ignorant and incompetent man, whose claim to the title of engineer rests on no substantial basis. It is clear then that the injury done to the profession when its members of high reputation commit unworthy acts is by far greater than can result from the acts of those hangers-on of the profession whom the public generally estimates at their real worth.

And if this is true, it follows at once that the members of the great engineering societies, and especially such members as have attained professional eminence owe to their fellow members and to the profession at large an avoidance of anything which may result in discredit to the profession. Perhaps there is no temptation which meets such engineers oftener than proposals of connections with "speculative" enterprises. We are far from saying that the engineer should on principle refuse all such offers. Every new enterprise must have something of a speculative character at the start. But it is clearly the duty of the engineer to scrutinize every such enterprise with the greatest care before associating himself with it in any capacity where the public may be led to place confidence in it by reason of his connection. The engineer who is asked as an expert to report on such an enterprise or who is offered an executive position in it must accept the responsibility that necessarily accompanies such a position. People who invest their money will do so on the strength of his opinions, and if the investment proves a loss, his reputation, and to a certain extent the reputation of the profession will suffer. The only safe rule to follow for an engineer in such a position is—to tell the truth and the whole truth. Ascertain the facts which count against the success of such an enterprise as carefully as you do those which make its prospects promising, and report them as faithfully to those who contemplate investment. This may seem Quixotic to some, but the engineer who pursues any other course is gambling with his own reputation.

What would be thought of a lawyer who in submitting a report upon the title to a piece of property included all the favorable documents and omitted any which threw a cloud upon it? Why should not the engineer be held to an equal responsibility? Is it not clear that he must be so held, if engineering is to be the honorable profession that it deserves to be?

It may be argued that investors could not be secured for enterprises if they were not painted in glowing colors. We do not believe this. Nearly every one who invests money in new enterprises would far prefer an honest, unbiased report of the prospects of failure and of success from an expert. It is not too much to say that the scheme which cannot attract capital upon a fair and impartial showing of its points of merit and of risk, ought not to succeed.

If there be any of our readers who hold that the position we have urged is too advanced for engineers, at the present day, we invite them to consider for a moment the result of taking an opposite position. Suppose, for the sake of argument, that an engineer is justified in presenting in his report only facts favorable to an enterprise. Suppose, we say that he may occupy an executive position in such an enterprise, and permit the distribution of misleading statements respecting its engineering features. If such a condition of affairs were to obtain, it is clear that engineers' reports would be worthless as a guide to investors: and we may be sure it would not take the public long to find out this fact. Would a banker be responsible if he occupied an executive position in a concern and permitted it to publish misleading statements as to its financial condition? Would an attorney be responsible, if, as one of the officers of a company, he misled investors as to its condition with respect to pending litigation? We realize well that in any such case the public would be prompt to hold such men to a due responsibility for their acts; and so in like manner does it hold the engineer responsible.

## LETTERS TO THE EDITOR.

### Paving Along Street Railway Tracks.

Sir: Referring to the article in the last issue of the Engineering News, entitled "Paving Along Street Railway Tracks," and the criticism of Mr. H. P. Jones, concerning the plan for paving along the street railway tracks in this village, contained therein, I wish to say that the plan covered only the paving proper and had nothing to do with the substructure of the track, the local authorities having no control over that portion of the work. Though strongly urged to put concrete under the ties, the local street railway managers refused to do so, stating that as they have to maintain the track in good order, they should have the right to choose the method of constructing it; and the village authorities are powerless in the matter as the laws relating to villages give them no control over the substructure of the tracks. I am aware that a durable or permanent street railway track can be best obtained by using a concrete foundation under the ties, but in the case noted such a roadbed cannot be secured.

Respectfully yours,
Wm. B. Landreth.

Cortland, N. Y., Oct. 17, 1896.

### A New Stadia Rod Graduation.

Sir: I enclose a design for the graduation of a stadia rod which is simple and easily read. The groups of divisions for each 100 ft. are alternated or staggered, and thus at long distances the hundreds of feet are more easily counted than if they were placed centrally on the rod. Another advantage is that no black division extends entirely across the rod, so that wherever the wires may cut, the white spaces which they cross are greater than the black.

Some engineers might prefer to have distinguishing numbers for each 100-ft. interval, but I have never experienced the need of such distinctions even when working in heavily wooded territory. Mr. Kenneth Allen has advocated the use of small mirrors, inserted at certain points on the rod, as an aid in avoiding mistakes at long ranges.

To prevent the graduations on the rod from being scratched or defaced, it is advisable to have narrow projecting strips down each side, and in order to protect the rod during transportation, the upper portion should fold forward upon the lower, so that the graduations are face to face.

Yours truly,
T. J. McMinn, M. Am. Soc. C. E.
277 Pearl St., New York city, Oct. 1, 1896.

## THE PROPOSED CANADIAN FAST TRANSATLANTIC STEAMER SERVICE.

Deeper canals, "fitted to handle the Western as well as the Canadian trade," are advocated by the Premier of the Dominion of Canada, and in this connection a fast Atlantic service between Canada and Great Britain is also proposed. But Mr. Sandford Fleming, M. Am. Soc. C. E., one of the most prominent engineers of Canada, has lately issued a pamphlet pointing out the difficulties of maintaining the 20-knot service on the St. Lawrence part of the route, which has been suggested. Speaking of the Belle Isle entrance he says that all

winds from the southward bring up fogs, requiring the greatest caution in navigation; and for 200 miles east and 100 miles west of Belle Isle, icebergs may be encountered. Within and sometimes even beyond these limits, the track of steamers is rarely free from icebergs, and fogs are nearly always present. Mr. Fleming concludes that any attempt to establish on this route a line of steamers intended to rival in speed those running from New York, would end in disappointment; and to secure an all-the-year-round line, Halifax, in Nova Scotia, and Loch Ryan, in Scotland, present the shortest available route for fast steamers. He says that this route is 300 miles shorter than to a Milford Haven terminus; 81 miles less than to Holyhead; 90 miles less than to Southampton, and 125 miles less than to Liverpool. But Mr. Fleming believed that steamships of moderate speed could be usefully employed on the St. Lawrence route in the transport of staple products and ordinary cargo; and that steamers suitable for this trade could, at the close of navigation, in the St. Lawrence, find an open harbor at St. John, N. B., the nearest suitable Canadian seaport for the cities on the great river.

In the same connection, Mr. John Torrance, of the "Dominion Line" of steamers, at the late launch of the steamer "Canada," said that this steamer was built for a 16-knot speed, and with this speed she had a cargo capacity of nearly 7,000 tons. But if this same steamer were equipped for an 18-knot speed her cargo would be reduced to 3,000 tons; and at 20-knots, to 1,000 tons. As a consequence, he said, if a fast service is desired it must be practically devoted to passengers alone; and the freight and passenger service must be separate and distinct. He thought such a fast service would not pay commercially.

Mr. T. G. Shaughnessy, Vice-President of the Canadian Pacific Railway, answered Mr. Torrance by saying that his experience was that if business was to be secured proper facilities must be provided, and that there was a happy medium between the extremes of high speed and great freight capacity. He illustrated his remarks by saying that with old and slow boats on the China, Japan and Vancouver route, the proprietors lost $150,000 in 1888, though they received from the C. P. R. 75 on all through rates. They rarely secured more than 30 first-class passengers on a voyage, and this number was reduced to 12 or 13 in the winter months. The Canadian Pacific Ry. Co. then built ships of 16½ knots speed, with accommodation for 175 first-cabin and over 1,000 steerage passengers, and with a freight capacity of about 4,500 tons. These ships he said have been a financial success almost from the start, and they carry from 160 to 170 first-cabin passengers in summer, and rarely less than 40 in the winter.

## COUPLINGS FOR MAKING LEAD AND IRON PIPE JOINTS WITHOUT SOLDER.

The accompanying illustrations show a method of connecting lead to lead, or lead to iron pipes, without the use of solder. Brass couplings are

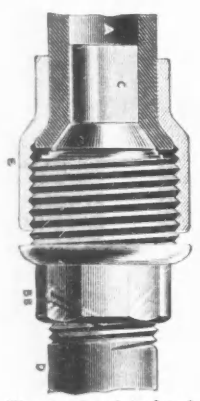


Fig. 1. Lead to Lead.

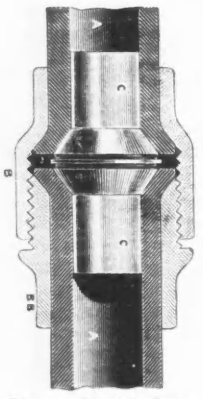


Fig. 2.—Lead to Iron.

**Figs. 1 and 2.—Couplings for Lead and Iron Joints. Made by the Monash-Younker Co., Chicago, Ill.**

used for this purpose, and the ends of the lead pipe are swedged up to fit against rubber washers resting on corrugated cone-shaped surfaces.

Fig. 1 shows the lead to lead connection. To make this joint the brass parts, B and BB, are swedged onto the ends of the pipe to be jointed, making use of a swedging tool and clamp furnished for the purpose. The tubular double cone, CC, with the rubber washer pressed against each cone, is then put in place and the couplings are screwed up tight. Fig. 2 shows a lead to iron joint and needs no explanation. A variety of other joints, tees and connections can be made in the same general way.

The couplers and fittings are made by the Monash-Younker Co., successors to the Van Auken Steam Specialty Co., 201 South Canal St., Chicago. The company states that they have been in use for the past three years, and presents testimonials to the effect that they have given satisfaction in water-back connections and other places where both hot and cold water are used. It is claimed that the rubber washer, as here used, coming in contact with lead and brass, only, is not subjected to the disintegrating effect observed in iron unions, where much oxidation is going on.

As compared with the lead wiped joint it is obvious that any mechanic with ordinary tools can make these connections with ease, and it is claimed that their first cost is less and their safety and durability is greater than that of the wiped joint.

## THE MAGNETIC SEPARATION OF NON-MAGNETIC MATERIAL.*

By H. A. J. Wilkens and H. B. C. Nitze, South Bethlehem, Pa.

The paradoxical title above used requires some explanation. The term "non-magnetic material" is applied to such substances as have heretofore been considered non-magnetic in the arts, more especially in the practice of ore-concentration.

Scientifically, it has been shown by Faraday, Plucker, Wiedemann and other physicists that magnetism is an inherent property common to all substances, solid, liquid and gaseous, i. e., all substances are either attracted or repelled by the poles of a magnet, although in the great majority of cases the manifestation of this force is so feeble as to be measured only by the most delicately arranged physical apparatus. The substances attracted are known as paramagnetic, and those repelled, constituting by far the greater class, as diamagnetic.

The diamagnetics show but a slight deviation in intensity as compared with air, which is the neutral substance. Bismuth is the most diamagnetic body known, and its diamagnetic permeability, expressed in figures, is stated to be 0.99982, taking air as unity. The paramagnetics, on the other hand, show a wide variation in intensity or permeability to magnetic forces.

There exists, however, a distinct and wide gap between such as are highly magnetic and such as are only feebly so, and accordingly two classes might be made, namely, such as can be and such as cannot be lifted by the common hand magnet or equivalent power. To the first class belong the metals iron, nickel and cobalt, and the minerals magnetite and pyrrhotite, and these are the only substances that are generally recognized as magnetic; while all other paramagnetics, comprising the second class possessing comparatively infinitesimal magnetic susceptibility, are regarded in the arts as practically non-magnetic. The abrupt gap between these two classes is not occupied by substances of intermediate and graduated magnetic susceptibility. It is with this second class of paramagnetic substances that we are concerned.

Faraday's list, published in 1846, includes a large number of metals, chemical salts and organic substances. It will suffice here to give the list of metals: Paramagnetic: Iron, nickel, cobalt, manganese, chromium, cerium, titanium, palladium, platinum, osmium. Diamagnetic: Bismuth, antimony, zinc, tin, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium,* rhodium, iridium, tungsten.

Various attempts have been made by physical investigators in Europe, with more or less success and reliabilty of results, to determine the specific magnetic permeability of substances. To give at least some idea of the great gap existing between the commonly known magnetic and some of the other paramagnetic bodies, the following results obtained by Delesse may be cited: Taking the magnetic attractibility of steel at 100,000, he found that of magnetite to be as high as 65,000, of siderite only 120, of hematite 93 to 43 and of limonite 72 to 43.

Practical engineers and inventors have either taken for granted that the magnetic susceptibility of substances was constant, and about what was indicated by the ordinary hand magnet, or, if they were acquainted with the universal magnetic permeability of substances, they have felt that the attainment of sufficiently high power to affect the extremely low susceptibility of the paramagnetics, other than iron, nickel, cobalt, magnetite and pyrrhotite, was impracticable within the bounds of practical economy. At all events, they have been discouraged from making any attempt to design electro-magnets capable of such peculiarly concentrated and condensed a field as to attract these substances.

Even in the present case useful results were achieved only after making many experiments and actual trials, carried on in the beginning, without any knowledge of the previous theoretical investigations.

A large number of machines have been invented and perfected for concentrating the so-called magnetic minerals, that is, magnetite and pyrrhotite, chiefly the former. When it became desirable to separate other ferruginous minerals, such as hematite, limonite, siderite, etc., which were in the generally accepted sense, non-magnetic, methods for converting them into artificial magnetite were resorted to. This was done either by an oxidizing or a reducing-roasting in or without the presence of carbon-contact.

On the same general principle, Mr. G. G. Convers, designed in 1892 a process for the separation of the franklinite-ore of the Franklin mines, New Jersey. This ore is a crystalline granular aggregate of franklinite, willemite and calcite, with smaller amounts of zincite, garnet, fowlerite, tephroite, etc. It was the object to obtain the willemite and zincite as free as possible from franklinite (the principal iron and manganese-bearing mineral), thus rendering the franklinite magnetic, so that it could be separated on Wenstrom magnetic drums. This process gave good results; but the cost of roasting and the uncertainty of a uniform magnetic product led to further experimenting, and finally the method, a direct magnetic concentration of these ores, without previous roasting, was evolved by Mr. J. P. Wetherill, manager of the Lehigh Zinc and Iron Co., South Bethlehem, Pa.

Mr. Wetherill found that not only the franklinite, but also the garnet, fowlerite, tephroite and similar deleterious iron and manganese-bearing minerals could be thus eliminated.

These surprising and important results were attained by utilizing a peculiarly high magnetic power, applied in machines especially adapted for the purpose, and sufficient to act upon the comparatively almost infinitesimal magnetic permeability of these minerals, instead of attempting (as had heretofore been done) to raise this low permeability to a point known in practice as "magnetic," that is, capable of attraction by a common hand-magnet or the electro-magnets heretofore employed.

Further investigations showed that a large number of ferruginous and manganiferous minerals, such as hematite, limonite, siderite, garnet, pyrolusite, etc., besides many chemical salts of iron, manganese and chromium were affected by this extraordinary magnetic power, and were thus adaptable to this method of concentration.

Letters-patent were granted to Mr. Wetherill for his method of direct magnetic separation of paramagnetic substances of low permeability from mixtures containing the same, as well as for the machines employed to obtain this result; and these patents are now owned by the Wetherill Concentrating Co., located at South Bethlehem, Pa.*

The machines for making these separations are of two types. In the first the magnetic particles are lifted away from the original mixture. The machine consists of two magnetic cores and bobbins and four pole-pieces, which are adjustable so that they may be moved nearer or farther apart as desired.

About each pole-piece revolves a belt.

The ore is fed from a hopper by means of a feed roller upon a belt which carries it in a thin layer, say ⅛ to 3-16-in. thick, in close proximity to the space between the poles, and the magnetic particles are withdrawn and lifted up into the highly intensified field existing at this point. They are removed by a horizontal belt and carried into a receptacle.

The non-magnetic tails fall from the belt into another receptacle.

The intensity of the magnetic attraction can be accurately adjusted by changing the distance of the feed-belt from the pole-points; or, by changing the distance between the pole-pieces, or, finally, by changing the amperage of the current.

So far machines have been used with a capacity of from ¾ to 3 tons per hour, depending upon the number of pole-pieces used, the speed of the belts and the nature and size of the material operated on. By widening the pole-pieces and the feed-belts, the capacity can be raised, but this may ultimately reach a point where it will be more advantageous to multiply the number of machines instead of further increasing their size.

The amount of amperage necessary for producing the extremely high field is comparatively small. This is due to the large-sized and correctly proportioned cores, yokes and pole-pieces employed, and the almost perfect condensation at the pole-points of the vast number of magnetic lines generated in them.

For the separation of the Franklin minerals, where the

*Abstract of a paper presented at the Pittsburgh meeting of the American Institute of Mining Engineers.

*According to later observations of M. Verdet, uranium is paramagnetic.

*U. S. patents Nos. 555,792 (dated March 3, 1896), and 555,794 (dated March 3, 1896).

magnetic heads produced consist of franklinite, tephroite, rhodonite, garnet, etc., from 3 to 8 amperes, with from 16 to 30 volts, are necessary. In the concentration of the Clinton red fossil-ore from 4 to 8 amperes were used. For limonite and pyrolusite a somewhat higher amperage is employed, from 10 to 15 giving a good separation.

The ability to adjust delicately the magnetic intensity of these machines permits, in many cases, the practical isolation from one ore of several products showing a slight difference of magnetic permeability. For instance, in the concentration of monazite sand the pure monazite can be separated from garnet and rutile at one operation, and the latter, by a slight change in the intensity of the current, can again be separated from each other.

Aside from the separation of several minerals from one ore, the discriminating power can be utilized for the separation of a desired quantity or quality of heads, where the magnetic mineral varies in itself in permeability. For example, in the concentration of the Clinton fossil-ores, the magnetic permeability of the hematite particles increases apparently with their percentage of iron, and either a small amount of high-grade heads can be produced with a low amperage, or a large amount of low-grade heads with a higher one. From a commercial standpoint, the exact quantity or quality which it would be advisable to produce would depend upon the increase in value of the concentrates per unit.

The machines described are adapted to dry concentration. Their arrangement for wet concentration would necessitate but a slight change in some of the mechanical features.

It is difficult as yet to judge of the full extent of the field to which this method of concentration is applicable. Its original application to the franklinite ores has been mentioned above. It should supplant those operations already enumerated, in which a magnetizing roasting has heretofore been found necessary before magnetic concentration, not only on account of the additional cost which the latter entails, but also because better results may be expected from the direct treatment of the raw material. Magnetizing-roasting is attended, in most cases, with considerable difficulties, such as the sintering and slagging of the ore, imperfect magnetization, etc., which not only decrease the quantity, but may also impair the quality, of the resulting concentrates. Such difficulties were encountered in the magnetization of the red fossil-ore of the Birmingham district and in the roasting of siderite-blende ores in several European localities.

Perhaps its widest application will be in the field of concentrating iron-ores, red and brown hematites and carbonates. It is estimated that over 90% of the material charged into the blast-furnaces in this country is of these classes, and that in European countries the proportion is even larger. These ores will practically be placed on the same level with magnetite, so far as the ability to concentrate them magnetically in the raw state is concerned.

Of importance to the iron and steel industry will be the concentration of manganese-ores, with which other methods of concentration, such as jigging, have always experienced difficulty and waste.

There are no doubt many other special cases in which this process of direct magnetic concentration may become applicable.

Among the materials, besides those mentioned above, which have been treated successfully are:

1. A mixture of apatite and rutile, occurring in a deposit near Charlottesville, Va.
2. Monazite-sands from North and South Carolina.
3. Garnetiferous rocks and schists, from which it was desired to extract the pure garnet.
4. Corundum ores, from which garnet and other deleterious ferrugunious minerals were to be removed.
5. Ores containing siderite as a deleterious ingredient, as in cryolite, for instance.

In certain metallurgical operations this method of magnetic concentration may form an intermediate stage, as, for instance, in the separation of pyrite from blende, after the mixture has received a dead roast to prepare the blende for the retorts.

Its application has not been exploited as yet in the chemical and other industrial arts.

Franklinite-Ores.—The process has been in operation on a large experimental scale at the works of the Lehigh Zinc and Iron Co., South Bethlehem, Pa., for the separation of the franklinite-ores. Some 15,000 tons of material have been treated here, and, on the basis of the experience thus gained, a large and comprehensive plant has been designed and erected at the mines of the Sterling Iron and Zinc Co., Franklin, N. J. This plant, having a capacity of 400 tons of raw ore per day, is about ready to go into operation. The ore, as it comes from the mine, is dried, crushed to 10-mesh size by means of Blake crushers and rolls, and sized. The franklinite, tephroite, rhodonite, garnet, etc., are removed on the Wetherill machines, leaving, as non-magnetic tails, a mixture of willemite, zincite and calcite, from which the latter is subsequently separated by jigging. The operation of the process on this material is highly successful, as is shown by the analyses at the bottom of the preceding column.

| | Wt. | Per cent. ZnO. | Fe. | Mn. |
|---|---|---|---|---|
| Run-of-mine ore | 100 | 31.09 | 20.34 | 9.34 |
| Franklinite separated | 56 | 24.38 | 35.50 | 13.62 |
| Willemite and zincite separated. | 28 | 60.00 | 1.50 | 6.10* |
| Calcite separated | 16 | 4.00 | .... | .... |

*This manganese is to a great extent chemically contained in the willemite and zincite.

Clinton Fossil-Ores.—Of more general interest, on account of the greater application of the process and the large extent of the field, are perhaps the results obtained on the red fossil hematite-ores of the Birmingham district in Alabama.

The richer, soft ores of this district, such as are used in the furnaces, average from 45 to 48% in iron, and from 30 to 24% in insoluble matter. Such ores occur, however, only in few localities, which are limited in extent, and are now almost exhausted. By far the greater portion of the leached ore-beds consists of material running from 35 to 45% in iron and from 45 to 30% in insoluble matter.

This latter class of ore cannot be used in the furnaces to advantage, and is therefore practically worthless, unless the percentage of iron be raised by concentration, and at the same time the insoluble matter be proportionately decreased.

The tests on these ores were made under the auspices of the Tennessee Coal, Iron & Railroad Co., and were in direct charge of Dr. William B. Phillips, the consulting chemist of the company, who, for the past three years, has made a specialty of the problems involved in the concentration of the Birmingham ores.

Various working-tests were made on material from a great number of localities, and the results were verified by some 500 analyses made in the laboratory of the company.

Concentration-tests on this material by the Wetherill process gave the following results (calculated on a basis of 100 tons of raw ore):

| | Iron. % | Insoluble. % |
|---|---|---|
| Original ore | 48.03 | 25.20 |
| | Iron. % | Insoluble. % |
| 57 tons of heads, containing | 57.10 | 13.10 |
| 28 tons of middlings containing | 46.20 | 25.40 |
| 15 tons of tails, containing | 10.00 | 70.80 |

It was further found that about 20% in weight of this raw ore could be brought up to: iron, 59.15%; insoluble, 10.45%.

At the prices offered for concentrates by the T. C. I. & R. R. Co., it would be perfectly feasible to purchase this grade of raw ore at the market-price, and make the concentrates at a profit. As, however, the ore of this quality is almost exhausted, the question of concentrating it on a large scale will hardly arise.

The above results compare most favorably with those previously obtained by the magnetizing-roasting process, particularly in the proportional amount of heads that were produced and the comparatively small percentage of iron carried in the tails.

The tests by direct concentration on the lower-grade ores showed a proportionately greater increase in the percentage of iron than those on the higher-grade material. The quality of the heads was, however, not as good, which shows that the hematite matrix in the low-grade ores carries a larger percentage of inherent insoluble matter than that of the richer ores.

Among others, the following results were obtained (calculated on the basis of 100 tons of raw ore):

| | Iron. % | Insoluble. % |
|---|---|---|
| Original ore | 41.58 | 37.51 |
| | Iron. % | Insoluble. % |
| 69 tons of heads, containing | 52.00 | 23.00 |
| 31 tons of tails, containing | 18.40 | 70.00 |

About 25% in weight of this original ore was raised to: iron, 56.40%; insoluble, 17%.

Tests were also made on the so-called "hard ore," which represents that portion of the ore-bed from which the lime has not been leached. The raw ore of this character, as used at the furnaces, averages: iron, 35.50%; insoluble, 17.50%; lime, 16%. From this were obtained from 50 to 60% in weight of heads, containing: iron, 48%; insoluble, 10.50%; lime, 10%.

The cost of mining this hard ore, on account of its being underground, is far in excess of that of the soft ore. And, therefore, although the use of such concentrates as were produced would be of great advantage in the furnace, the cost of mining 2 tons of raw ore would be too great to permit the use of 1 ton of concentrates obtained therefrom at a profit under present circumstances.

The above tests must be considered to a certain extent preliminary. There is no doubt that a wider experience with this material, and, as a rule, a somewhat finer crushing and more judicious sizing, will give still better results. Experiments have gone far enough, however, to prove that this process of direct magnetic concentration is not only technically the most feasible, but also commercially the most economical ore.*

Brown Hematite-Ores.—To show the application of the process to brown hematite-ores, the following results, from experiments made at the testing-plant of the Wetherill Concentrating Co., South Bethlehem, Pa., may be of interest:

*It is regretted that business negotiations and commercial calculations are not far enough advanced to permit figures of costs and value of the concentrates to be published at the present time.

Brown Hematite from Iron Gate, Va., Allegheny Iron Co.

| | Percentage by weight. | $SiO_2$. Per cent. | Fe. Per cent. |
|---|---|---|---|
| Original ore | 100 | 31.29 | 42.08 |
| Concentrates | 63.4 | 11.24 | 51.04 |
| Tails | 36.6 | 66.00 | 31.74 |

Brown Hematite (Washer Tailings), Barren Springs, Va.

| | Percentage by weight. | $SiO_2$. Per cent. | Fe. Per cent. |
|---|---|---|---|
| Original ore | 100 | 29.93 | 32.03 |
| Concentrates | 30 | 7.43 | 53.14 |
| Tails | 70 | 39.58 | 22.98 |

Jigged Zinc-Ore (Consisting of Limonite and Calamine), Wythe Lead & Zinc Co., Austinville, Va.

| | Percentage by weight. | Fe. Per cent. | Zn. Per cent. |
|---|---|---|---|
| Original ore | 100 | 18.60 | 29.57 |
| Concentrates | 33 | 49.45 | 5.58 |
| Tails | 67 | 3.41 | 41.40 |

In the application of this process, limitations will be encountered similar to those common to other methods of concentration. The constituents of the material to be concentrated must exist in a visible mechanical mixture, so that, after crushing, each constituent may be present in separate and distinct particles. As already stated, the Wetherill machines have successfully handled material up to ½-in. in diameter, and a coarser crushing than this is seldom advisable in concentration. As a rule, finer crushing is necessary on account of the structural condition of the raw material, as in the case in the Clinton fossil ores.

The antipathy against the use of fine ores in the blast-furnace has been greatly overcome by the successful utilization of the Mesabi fine ores in the Pittsburgh district, where 33% of material, running less than 8-mesh in size, constitutes the regular furnace-charge, and as high as 60% has been used without serious difficulty. Briquetting may, in some cases, be resorted to, especially where a self-fluxing and partially self-reducing briquette can be made, and where these advantages counterbalance the additional cost of manufacture.

When the difference between the magnetic permeability of the constituents is marked, a preliminary sizing of the material is unnecessary; but this must be resorted to, and the number of sizes be proportionately increased, as the magnetic difference becomes less. The process resembles in this respect an air or water-separation. In rare instances this difference may be practically nil, and a separation may become impossible. Such was found to be the case in the attempted separation of chromite and serpentine in a certain chrome-ore, these two ingredients showing practically the same magnetic properties.

Experience has shown that the actual cost of magnetic concentration, under usual conditions, will not exceed 5 cts. per ton of raw ore. The cost of preparing the ore for the machines by drying, crushing and sizing will depend to a great extent upon the character of the ore, locality of the deposit and other conditions, and will not differ from the corresponding cost under any other method of concentration.

## SUSPENDED ARCH-CENTERS AT THE PORT OF BORDEAUX.

In building the new quays at the port of Bordeaux, France, the bad character of the soil and the unstable condition of the older works founded upon piles, at that place, made it necessary that some general plan be adopted that would reduce to the lowest degree the effect of the outward thrust of the filling material. With this end in view the engineers concluded to employ masonry arches, placed at right angles to the pier-line, and to support these arches by piers founded by the use of compressed air. The reasons for the employment of this system and a full illustrated description of the construction of these quays will be found in the "Annales des Ponts et Chaussees," for June, 1896, in a lengthy and interesting paper written by Mr. A. Pasqueau, Chief Engineer. One of the most novel features of construction was the use of suspended centers for the masonry arches connecting the piers, and these may be described as follows:

The foundation soil was made up of strata of mud, from 16 to 20 ft. deep, muddy sand and gravel, from 7 to 20 ft. deep, and a compact bed of yellow marl, or clay, lying from 50 to 66 ft. below datum; and upon this latter formation the piers were founded. This quay is 4,959 ft. long and required the sinking of 93 metallic, rectangular caissons or pier-foundations, by the employment of compressed air. The datum line used was 21.55 ft. below the highest known tide, and the height of the front edge of the quay was fixed at this highest tide mark. The normal rise of the tide is 18.04 ft. The face-width of the piers was fixed at 4 m., or 13.12 ft., from the springing line of the arches to 23 ft. below datum, and 5.4 m.,

or 17.71 ft. wide from that point to the foundation. The general length of these piers was 10 m., or 32.80 ft., with a face batter of 1 in 10 from the top to a point 23 ft. below datum. At this latter point a horizontal step increased the bottom length to 34.44 ft. Out of 93 piers, 9 were doubled in face dimensions, or made 8 m. wide at the spring, to support heavy cranes, etc.

The springing line of the arches was fixed at 1.50 m., or 4.92 ft. above datum, and the normal arch span was 12 m., or 39.36 ft., with a rise of 2 m., or 6.56 ft. The width of the arch was 10 m., or 32.80 ft. Upon the completion of the arches the openings were closed by a filling of broken stone, having side slopes of 45°, and with the front-toe

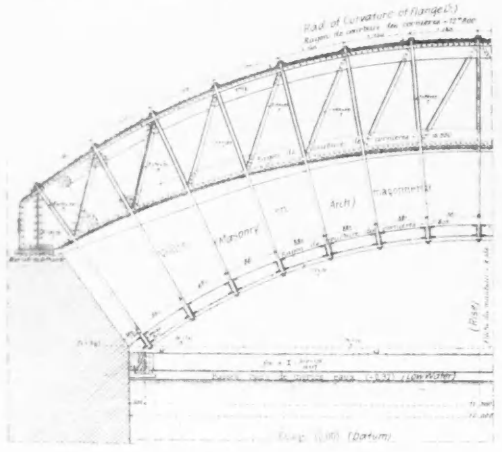


Fig. 2.—Details of Suspended Centering

of the filling terminating on a line with the face of the caissons at a general depth of 23 ft. below datum. The top of this rock embankment extends up to the crown of the arches and sand was used as a back filling. The arches themselves, the face wall above them, and the front faces of the piers, to a point 23 ft. below datum, are built of cut stone.

The springing line of the arches was 2 ft. above the level of mean low water, or 4.9 ft. above datum, and it might have been possible to have used centering of the ordinary type; but such a center would have been very difficult to place and to strike, owing to the slight height available. In this emergency, the contractors, Messrs. Zschokke and Terrier, devised the system of suspended centers here described and illustrated.

The elevation and photographic view show the design adopted for this purpose. The contractors at first used two steel, trussed ribs, spaced 8.53 ft. apart, to support a center 16.4 ft. wide, and built the arch, which was 32.8 ft. deep, in two sections. But they later employed three ribs and built the whole arch at one operation. As shown in the elevation, these trussed ribs rested upon iron plates fixed upon the piers at an elevation of 3 m., or 9.84 ft. above datum, and, by long rods arranged normally to the intrados of the masonry arch, these trusses supported a series of metal panels, 2.88 ft. wide, forming the center desired. The stone arches were built upon this center in the ordinary manner, by leaving holes for the passage of the supporting rods. After a sufficient time had elapsed the centers were readily struck by loosening the nuts at the top of these rods and the centers were then lowered onto boats and transferred to adjoining piers by utilizing the rise and fall of the tide.

Mr. Hersent, who had a later contract on the same work, preferred to use a floating center for his arches; but for those of slight span and rise he also employed the suspended centers, and he recommends them for emergencies of this character. The Hersent floating center was composed of six metal trussed ribs following the curve of the intrados of the arch and the line of the chord of the arch. The two outer trusses at each end were enclosed in plates in such a manner as to make tight boxes provided with manholes, air-pipes, valves, etc., and the upper part of this center was covered with wood for the support of the arch voussoirs. Iron-trussed beams were

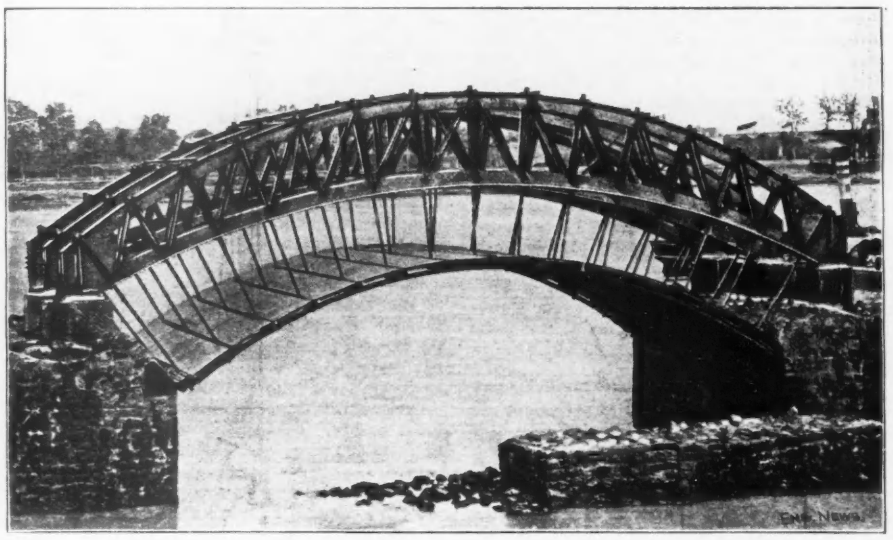


FIG. 1.—VIEW OF SUSPENDED CENTERING AT THE BORDEAUX HARBOR, FRANCE.

put in place, below the spring of the arch and between the piers, to support this floating center with its wedges, etc., as shown in Fig. 3.

The placing in position of this centering was simple. The center was floated by emptying the two tight boxes, at the ends, and was guided between the piers at high-tide; it was then settled down upon the cross beams, put in place at low tide, by introducing water into the end boxes. The water was left to circulate freely between the four middle ribs of the center. Upon the completion of the arch the wedges were struck in the ordinary manner; the end boxes were again emptied and the center withdrawn and floated to the next pier. It should be remarked that where these floating centers were employed the springing line of the arches was 8.20 ft. above datum, owing to a change in the type of the piers. The weight of one of these floating centers was about 39,600 lbs. and its cost was estimated at $1,200, not including the beams below the springing line; it drew 2.16 ft. of water with the end boxes empty The cost of handling this center for one arch was about $25, or about 20 cts. per cubic yard of arch masonry.

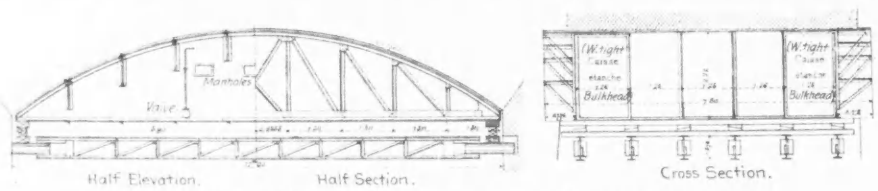



FIG. 3.—FLOATING CENTERS FOR ARCHES AT THE BORDEAUX HARBOR.

## THE THIRD RAIL ELECTRIC SYSTEM ON THE NEW YORK, NEW HAVEN & HARTFORD R. R.

During the past summer the New York, New Haven & Hartford R. R. Co. installed the third-rail electric system on 3½ miles of the South Shore branch of the Plymouth division. This is the first surface railway that has ever operated its cars by a conductor laid upon the ground. A three months' trial has proved the success of the system for ordinary railway traffic at high speed. That part of the line where the third rail is laid is a continuation of the track on which the trolley is used. The trolley line is about seven miles long from Nantasket Beach to Nantasket Junction. At the end of this line the trolley slips from the end of the overhead wire, is pulled down and fastened and contact is made with the third rail. A knife switch under the hood of the car being closed, the current from the third rail is thrown into the motors and the operation of the train continues without interruption. The current for the third rail is brought from the power-house over two insulated feeders of copper cable laid along the tops of the poles which carry the overhead wires of the trolley division. At Nantasket Junction the feeders are dropped to the ground, and each is connected to its own third rail.

The third rail is of peculiar shape (Fig. 2), the end view resembling a flattened A; this form is used because it is cheaper than standard sections. It is laid in the middle of each track. Each section of third rail is 30 ft. long, and weighs 93 lbs. per yard. It is supported by three ash blocks to each section, the blocks being let into the ties. Before use these blocks were boiled in vacuum pans

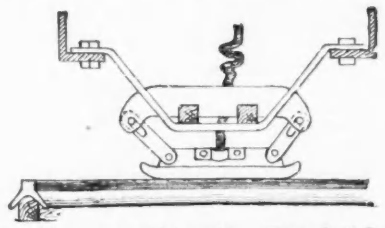


Fig. 1.—Side View of Sliding Shoe, Third Rail System; New York, New Haven & Hartford R. R.

with a tar compound, and the cells thus filled with insulating and preservative material. At each rail-joint are two heavy copper bonds.

The current is taken from the third rail by two sliding shoes (Figs. 1, 2, and 3) hung loosely from the car, one suspended between the axles of each truck by two slotted links which allow it to slide easily on the top of the third rail. The current is brought to the motors through the controllers and circuit breakers, and returns to the track rails by the wheels. The distance between the two shoes is 33 ft. No third rail is laid at the crossings, the circuit continuing between the broken ends by means of lead covered underground cables. At crossings less than 30 ft. wide, one of the shoes remains in contact, at wider ones the impetus of the moving car brings the shoes into contact again before the car can come to rest. The widest crossing which is run over in this way is 1,200 ft. Each shoe is a cast-iron plate 12 ins. long and 5 ins.

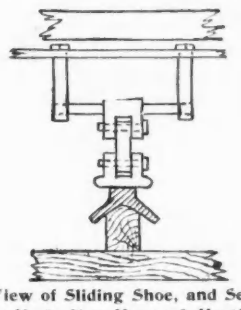


Fig. 2.—End View of Sliding Shoe, and Section of Third Rail; New York, New Haven & Hartford R. R.

wide, and weighs about 20 lbs. It is connected to the motor by a flexible cable. No difficulty has been experienced by the heating of the shoe from the friction, which is due probably in part to the air rushing past it, keeping it cool.

The air for the brakes is supplied by an elec-

trically driven air compressor automatically controlled by the air pressure itself. The apparatus consists of a double vertical air pump (Fig. 4) with single-acting cylinders, 5¾ × 7-in. stroke, directly connected to a series motor, the lower field of which is extended to form the base of the pump. The capacity of the pump is 52½ cu. ft. of free air per minute, working against 90 lbs. pressure per sq. in. At this pressure the speed is 250 revolutions at 600 volts.

The air compressor is piped directly to the main

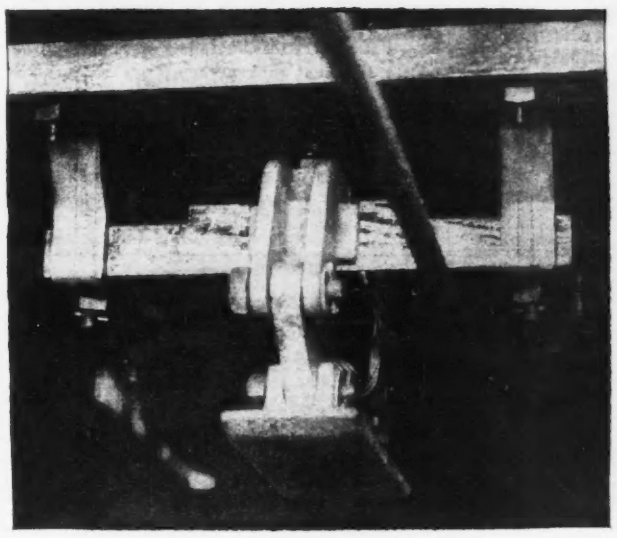


Fig. 3.—Cast-Iron Contact Shoe in Position; N. Y., N. H. & H. R. R.

reservoir, and is controlled automatically by a pneumatic governor consisting of a cylinder containing a piston working against a spring. The action of this automatic control is as follows: The pipe running from the main reservoir enters the cylinder below the piston. As the pressure rises the piston is forced upward against the spring. The other end of the piston rod carries the contacts through which the pump-motor circuit is made and broken. Any arcs that may be made when the contact is broken are blown out in a magnetic field, the coils of which are connected directly in series with the motor. As the pressure in the reservoir falls from 5 to 7 lbs., the piston is forced back by the spring, the contacts are pushed down to their seat, the circuit is closed, current flows to the motor and the compressor starts. The circuit remains closed until the pressure reaches normal when it overcomes the force of the spring, forces the piston upward, breaks the contact and the motor stops. This operation is repeated automatically, the machine requiring practically no attention. The governor can be adjusted to any pressure from 45 to 100 lbs. and works on a difference of from 5 to 7 lbs.

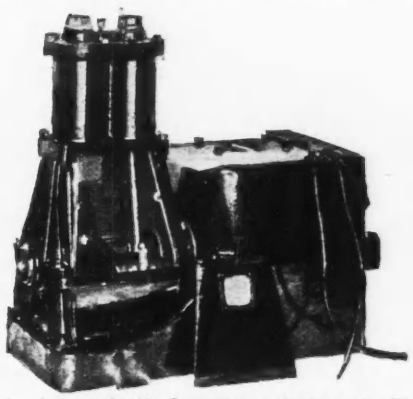


Fig. 4.—Automatic Air Compressor Used on the Electric Cars of the New York, New Haven & Hartford R. R.

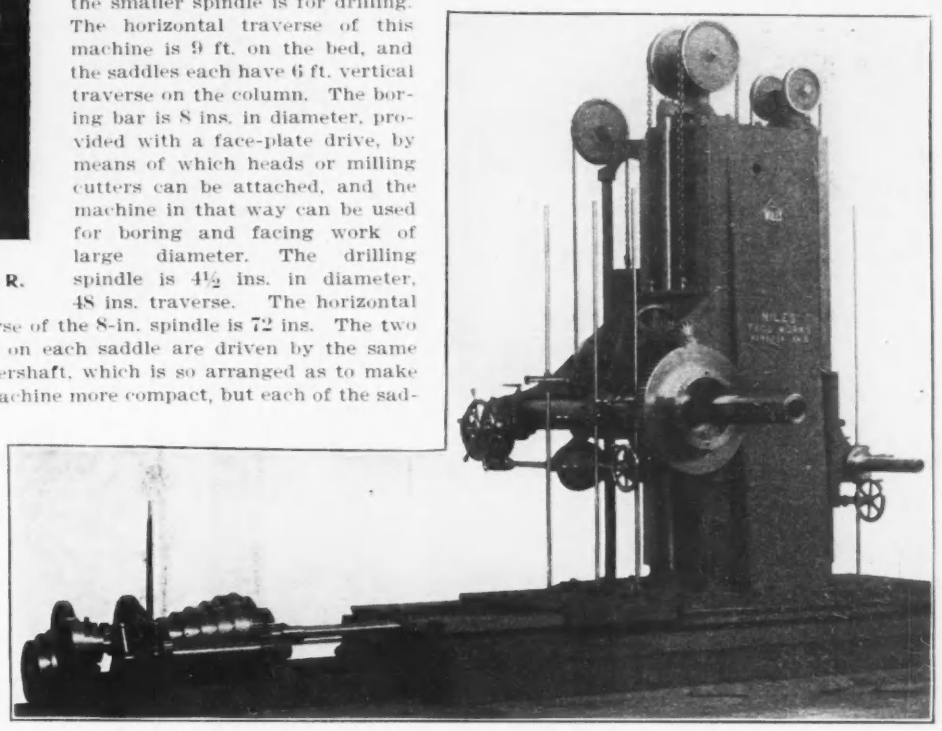
Before the third rail was installed two steam locomotives were used on the 3½-mile stretch from Nantasket Junction to East Weymouth. These locomotives burned each day four tons of coal apiece. With the new arrangement not more than four tons are used to generate power for the entire seven miles between Pemberton and Nantasket Junction. Trains have been operated at a speed of 70 to 80 miles per hour.

We are indebted to the General Electric Co. for the accompanying illustrations and the information from which this article was prepared.

## A HEAVY HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

We illustrate herewith a powerful two-spindle horizontal boring, drilling and milling machine, recently built by The Niles Tool Works Co., of Hamilton, O. The cut shows the machine without the floor tables. These are attached to the bed. They are made either square, circular or rectangular in shape, as may be desired, for the particular work that is to be done on the machine.

The column is traversed on the bed, and is supplied with two saddles on opposite sides of the column. The saddle with the large spindle is for boring purposes, and the smaller spindle is for drilling. The horizontal traverse of this machine is 9 ft. on the bed, and the saddles each have 6 ft. vertical traverse on the column. The boring bar is 8 ins. in diameter, provided with a face-plate drive, by means of which heads or milling cutters can be attached, and the machine in that way can be used for boring and facing work of large diameter. The drilling spindle is 4½ ins. in diameter, 48 ins. traverse. The horizontal traverse of the 8-in. spindle is 72 ins. The two heads on each saddle are driven by the same countershaft, which is so arranged as to make the machine more compact, but each of the saddles are independent of one another in every respect, and are so connected with the driving shaft (which is of large diameter) that either one or the other of the spindles may be thrown out at will. The driving cone is provided with six steps, and is powerfully back-geared. Each of the spindles is nicely counterweighted, and all the feeds and movements of the saddles are within easy reach of the operator, a platform being provided close to each saddle. The weight of this machine is about 80,000 lbs., without any floor plates. It is particularly adapted for large floor plates. It is particularly adapted for large engine work, electric generators, ship building, etc.



HORIZONTAL BORING, DRILLING AND MILLING MACHINE.
Built by The Niles Tool Works Co., Hamilton, O.

## A DOUBLE-BLADE SEMAPHORE FOR BLOCK SIGNALING ON THE PARK AVE. VIADUCT; N. Y. CENTRAL R. R.

The new four-track steel viaduct of the New York Central R. R., in New York city, which extends from 110th St. to and beyond the Harlem River, will have a very complete system of lock-and-block equipment, and all the signaling and interlocking plant has been installed by the National Switch & Signal Co., of Easton, Pa. On this viaduct the two western tracks are used for northbound trains and the two eastern tracks for southbound trains, the trains keeping to the left on this part of the line in consequence of the arrangement of the Grand Central terminal station at 42d St. The first signal station for the viaduct line is at 110th St., and this has 12 levers, operating 4 double-blade signals, 4 distant signals and 4 torpedo signals. The station at 125th St. has 22 working levers, operating 8 double-blade signals, 6 distant signals and 4 mechanical slots. The great four-track drawbridge, 400 ft. long, which crosses the Harlem River, between 133d and 135th Sts., is protected by signals controlled from a tower at 135th St., on the north side of the river.

In designing the signal plant, one requirement to be met was that of the officers of the railway to the effect that the system of lock-and-block working which has been in operation for some time in the Fourth Ave. tunnel, should be extended as far as 135th St. Pot signals are used in the tunnel, showing three colors; green, red and white. The block instruments used to control these pot signals are double instruments controlling two levers, and since the two levers operate the same signal, it was necessary to design a movement which would permit of the two levers operating on the same line of connections to the same signal. This was successfully carried out in the tunnel, and since all the signals on the elevated structure are high semaphore signals, it became necessary to design a special signal for that work.

Before proceeding further with the description of the special form of signal designed to accomplish the desired end, it is necessary to explain the purpose of using both red and green. It has been found desirable to use the red and green in the lock-and-block system so that in case of failure of the track circuit or apparatus operating and controlling the signal preventing the giving of a clear signal, it would be possible to pass trains over the road by clearing the red (or "stop") signal, leaving the green (or "caution") signal in the horizontal position. This indicates to the engineman that while both arms are not in a clear position he may proceed since the red signal was cleared, knowing that the only reason he does not receive the white signal is that the apparatus is out of order. It might seem that this is a condition which it is hardly necessary to provide against, but owing to the enormous volume of traffic on these four tracks (which carry all the trains of the New York Central R. R. and the New York, New Haven & Hartford R. R.), it was found that notwithstanding the most careful supervision of the work there were times when trains would be delayed unless this compound signal, as it might be termed, was operated. This is not really permissive signaling, for the red signal cannot be cleared unless the section in ad-

vance is unoccupied, but it is a special system introduced in order to provide for the prompt and safe handling of a very heavy traffic. This plan, it will be seen, avoids the necessity of stopping each train while the fireman goes to the signal tower for a green caution card to allow the train to pass the red signal under "caution" as far as the next signal tower. There are two separate circuits, one for each signal (the white and the green) so that it is impossible for an operator finding he cannot give the "white," and assuming that the apparatus is out of order, to give the "green" when as a matter of fact there is an obstruction on the track.

The following rule for signalmen governing this is included in the rules issued over the signature of Mr. J. H. Franklin, General Manager of the Harlem Line:

Give three (3) bells to get unlocked on your red signal. If advance tower fails to unlock you on red you will put your slide in normal position, which is back. Then pull your green slide in center position and give three-one (3-1) to man in advance tower, and he will unlock you on the green lever. If both fail, use the "Clearance Card" and flag the train.

The style of double-bladed semaphore signal designed to meet these requirements is shown in the accompanying cuts. Fig. 1 shows the signal at the danger (or "stop") position, with but one semaphore blade visible. Below the regular blade grip will be seen an auxiliary or floating spectacle. There are two up-and-down rods, coupled onto a system of compound levers at the base of the pole. The adjustable jaws on these rods are slotted, as is the top of the outside up-and-down rod where it connects with the blade grip. The floating or secondary spectacle is actuated by a horizontal slot in this up-and-down rod. In the case of the Harlem River work the signal is operated by a single line of pipe. The interlocking machine in the tower has two levers for each home signal, one red and one green, and these levers are coupled to a compound lever below the machine, which in turn is coupled to the rocking shaft.

The normal position of the levers and signal is at danger and in case a clear signal can be given, the operator simply reverses the red lever, thereby clearing both arms as shown in Fig. 2. In case a clear signal cannot be given by reason of any failure in the apparatus, the operator reverses his green lever thereby exerting a pull on the line of connections which lowers the outside or red arm to an angle of 65°, leaving the green blade in the horizontal position as indicated in Fig. 3.

It will be seen by Fig. 3 that the floating spectacle is moved upward to a position in front of the lamp when the green lever is reversed; but when the red lever is reversed, clearing both arms, this spectacle remains in the position shown in Figs. 1 and 2, so that the white light shows between the floating spectacle and the spectacle in blade grip, as in Fig. 2. The blade grip on the green blade is not fitted with glass and simply acts as a counterweight.

Owing to the use of the slot in the adjustable jaws of the up-and-down rod, the reversing of the green lever does not actuate the up-and-down rod connecting with the green blade; while in reversing the red lever, the up-and-down rod actuating the red blade is not moved, the red blade being carried down by a lug on the blade grip of the green blade, which engages with a corresponding lug on the blade grip of the red blade, so that when the green blade is cleared it carries with it the red blade without actuating the floating spectacle.

This style of semaphore signal is applicable for ordinary permissive block signaling. In this case, however, it is not necessary to have two levers in the interlocking machine, as one lever can be made to do all the work, one arm being lowered by the half stroke, and both arms by the full stroke of the lever. This can be operated with either pipe or wire, but for block signal stations where the expense would be but little greater if pipe were used, the use of pipe is recommended as giving a more positive connection.

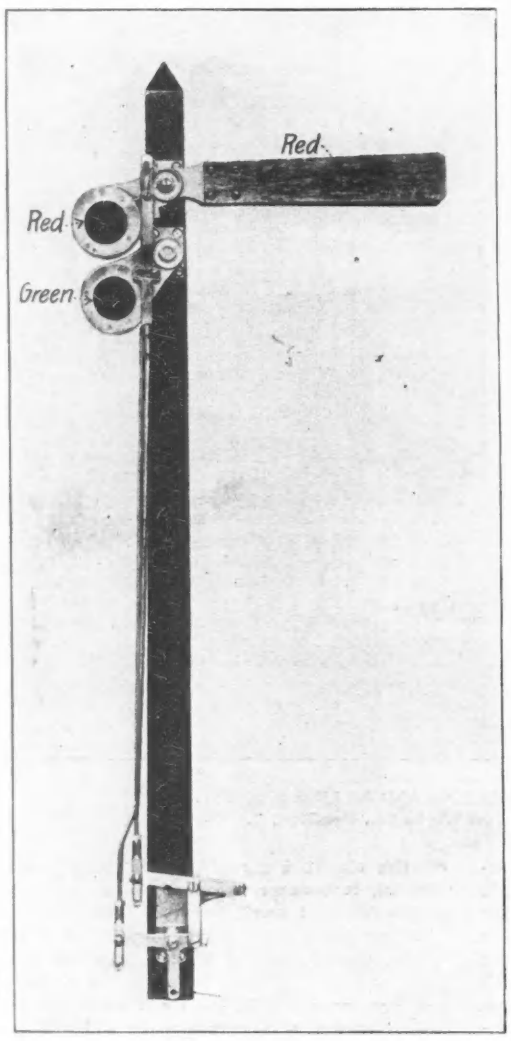



Fig 1.—Normal Position, "Danger."

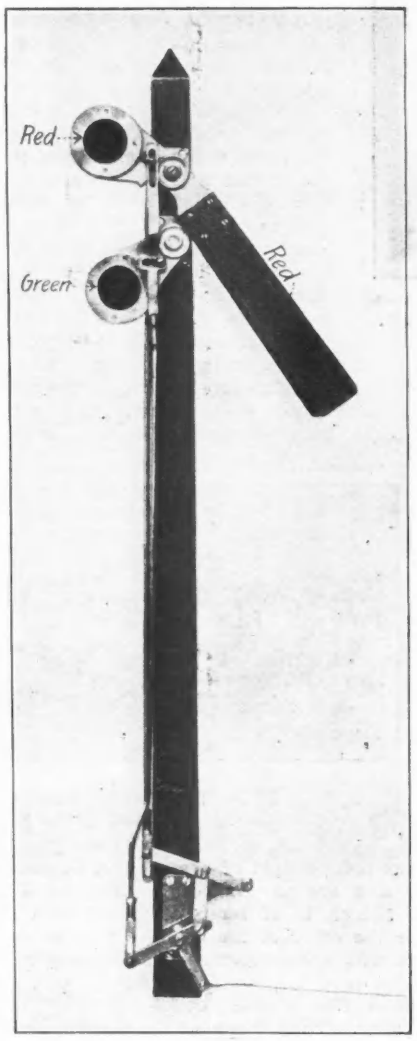



Fig. 2.—Position for "Track Clear."

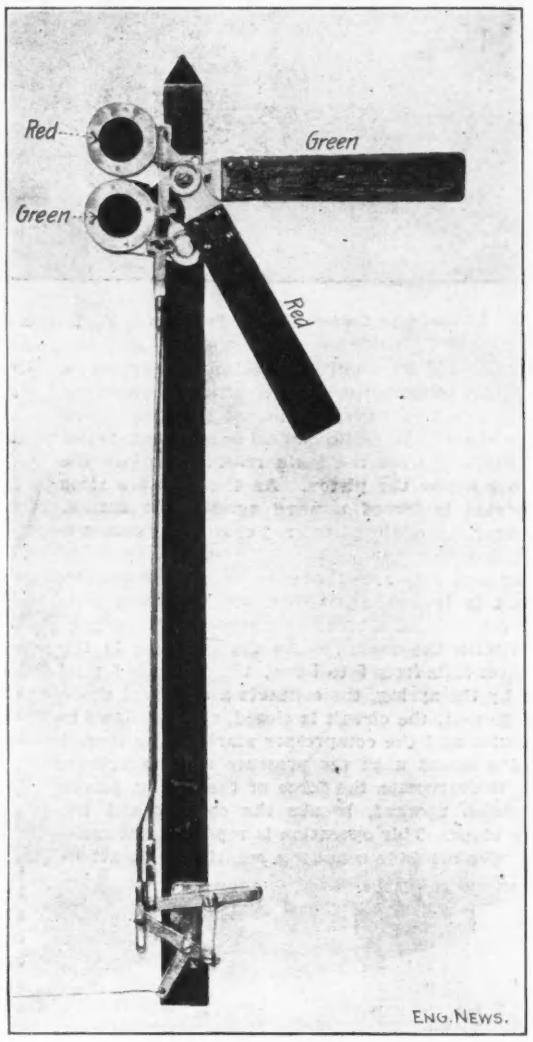



Fig. 3.—Position for "Track Clear," When Signal is Inoperative.

**DOUBLE-BLADE SEMAPHORE FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R.**
**Designed and Installed by the National Switch & Signal Co., Easton, Pa.**

## THE ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The third annual convention of this society was held in Chicago, Oct. 14, 15, 16 and 17, 1896, and proved very successful both socially and in the character and variety of the technical papers and discussions. The total attendance was about 150 members, about half of whom were in constant attendance at the meetings. Altogether 21 papers and 6 reports of committees were considered during the six working sessions, rather too large a number for the proper discussion of all, yet by grouping the reports and papers on the same subject and discussing them in a body instead of individually the time was used to the best advantage. Some time was lost in irrelevant discussion, but the presiding officers kept such discussions pretty well in hand, all things considered. The discussions also lost something in interest through the fact that the members had to base their remarks upon what they could catch from hearing the papers read. It is to be hoped that the society will be in a condition by another year to have the papers printed and distributed to the members some time in advance of the convention.

The opening session on Oct. 14 was devoted to routine business and the usual addresses of the President and others. Mayor Geo. B. Swift, of Chicago, welcomed the convention to the city with a few brief remarks. Mr. Geo. G. Benzenberg, M. Am. Soc. C. E., the president of the society, then presented his annual address. Mr. Benzenberg called attention to the fact that the society's

bject was not so much to secure better city governent as it was to secure to the citizens and taxpayers such municipalities the most economical and best class public improvements obtainable. He continued in part follows:

Millions of dollars are annually expended in reconstruction too frequently made necessary by the introduction of improper material, imperfect plans or by the lack of information and experience of those into whose hands such work has been intrusted. It is not to be supposed that the conditions largely responsible for such state of affairs are likely to be remedied, excepting through the slow process of development towards a more stringent and accountable administration of public affairs. With such evolution, however, this society has no connection, its object being distinctly to improve our competency and efficiency in the discharge of our respective duties by the interchange of experience, by the presentation and discussion of papers, and by preserving in our proceedings for mutual reference and study such practical information as may be collected.

Although meeting to-day for the third time, this society was not fully organized until at its last meeting in Cincinnati, nor were its objects fully set forth nor its work intrusted into the hands of committees until at that meeting, hence no organized work of the convention was possible until now. The faithful and arduous work of the committees, represented in their reports at this meeting, indicates what may be accomplished by systematic and careful investigation, and the numbers and subjects of the papers to be presented demonstrates clearly the interest of our membership in the questions most prominent in municipal improvements to-day. This work, however, should be expanded, taking in every kind of municipal government in all its legislative and administrative branches, uniting them all into one organization whose work could be divided into sections under each department head, considering all topics not only in the entirety but in all its details, for it is the latter that most frequently puzzle the inexperienced in our smaller cities where growth demands new improvements. The best methods of selecting paving bricks, of testing sewer pipes, paving and other cements, the most satisfactory and economical system of cleaning streets, of collecting garbage and ashes, of cleaning or flushing sewers, the best manner of regulating the too promiscuous opening of street pavements by corporations and individual property owners, of introducing protective sanitary measures in all house plumbing and draining, of securing the best railway track construction in streets, the abatement of smoke and other nuisances, the regulating of traffic by a wagon or tire tax, of providing the best kind of underground service for all classes of wires, of securing to the public a suitable return for all corporate franchises, of enforcing honest competition and honest work on the part of contractors for public works, are some of the questions in which all are interested and many of us seek the experience of other cities.

The rapid development and growth of many cities make necessary that municipal improvements assume a more permanent and durable character, obviating the necessity of frequent reconstruction. Temporary expedients in municipal work are too frequently expensive mistakes and should be always discouraged. It is preferable that progress in improvements be slow so they assume a permanent character and relieve the property owner as much as possible from the burden of reconstruction. Such practice, of course, is not always in the first instance approved of by the taxpayer, but there is no lack of object lessons to demonstrate its economy. Our efforts as an organization should be exerted in that direction and its work will be more readily appreciated by the citizens when they observe that perfection, durability and economy are the motives which direct our convention labors. Much study and committee work will be required to sift out the best methods and results from the different local experiences.

The report of the Secretary and Treasurer showed the society to be somewhat in debt, but in such a condition that the coming year with its increased membership might see the debt cleared away. To provide for future contingencies it was decided to consider at the next meeting the revision of the constitution so as to increase the annual dues from $3 to $5.

In the afternoon session the business of reading and discussing the committee reports and papers was begun. These were divided under the following heads: Street Paving, committee report and twelve papers; Electric Street Lighting, committee report and one paper; Sewerage and Sanitation, committee report and two papers; Water-Works and Water Supply, committee report and five papers; report of committees upon Taxation and Assessment, and City Government and Legislation; paper on Garbage Disposal at Milwaukee. In this report of the proceedings of the convention only a brief summary of the various papers and the discussion which followed them will be given, but in future issues it will be the purpose to present some of the papers in more extended form.

## Street Paving.

The consideration of this subject was opened by the presentation of the corresponding committee report by Mr. A. D. Thompson, City Engineer, Peoria, Ill., Chairman. Its substance was that the committee had deemed it best at the present session to devote its attention simply to securing papers covering different branches of the problem. Twelve such papers had been secured and would be presented.

Under the title of "Advantages of an Asphalt Testing Laboratory," Mr. N. P. Lewis, Brooklyn, N. Y., described the asphalt testing laboratory established in that city at a cost of some $2,500. Although recently installed this laboratory had shown its value in many respects and gave promise when the analyses and tests had progressed further, of furnishing much valuable data for the use of the department. A paper on "Specification Requirements for Asphalt, Asphalt Mixtures and Tests for Asphalt," by Mr. A. W. Dow, Inspector of Asphalts and Cements, Washington, D. C., was read by title and will be further considered in another issue. Two papers of a descriptive character followed: One entitled "Paving Street with Brick," by J. S. Hathaway, Chairman Street Committee, Marietta, O., and the other entitled "Paving in Nashville, Tenn.," by J. L. Kennedy, Member Board Public Works, Nashville, Tenn. Mr. F. W. Cappelen, City Engineer, Minneapolis, Minn., in a paper entitled "Modern Street Railway Track Construction on Asphalt Paved Streets in Minneapolis," described the special methods of track construction adopted in the city mentioned. Some of the particular features of this work will be presented in a future issue. The paper following was by Mr. A. D. Thompson, City Engineer, Peoria, Ill., entitled "Testing of Paving Brick," and described the absorption, transverse breaking, and abrasion tests adopted in the city mentioned and already described in Engineering News.

Two papers discussing regulations for opening street pavements were read by Capt. Lansing H. Beach, U. S. Engineer Corps, Washington, D. C., and Mr. G. D. Snyder, City Engineer, Williamsport, Pa. Capt. Beach gave in much detail the laws and regulations governing the opening of pavements in the National Capital, where the restrictions were very stringent as compared with most other cities. In Williamsport the idea followed is to anticipate future openings as far as possible by requiring all improvements to be made before the pavement is laid. When openings are necessary the permit is charged for at the rate of the original cost per square yard of the pavement to be opened. In replacing the pavement the person opening it is required to fill the trench as thoroughly as possible, and then, whatever the foundation of the original pavement, to lay a concrete foundation spanning the trench for the new pavement. This construction had been fairly satisfactory in preventing settlement.

In a paper on "Rumbling of Brick Pavements," Mr. E. Adam, Engineer Board Street Commissioners, Newark, N. J., described the troubles of this nature experienced in the city mentioned. He found that the rumbling occurred on pavements with grout filling, but not on pavements with sand filling, and was disposed to attribute the cause to expansion which raised the pavement from its foundation. A paper on "Improved Streets and Their Care," by Col. M. A. Downing, Chairman Board of Public Works, Indianapolis, Ind., followed next and described briefly the work of the city named in the matter of street paving. Practically all the work of improving streets in Indianapolis had been done within five years, and that city now had, exclusive of the work done in 1896, 28 miles of asphalt, 15 miles of brick, 5 miles of wood block and 2 miles of macadam. These pavements, except in a few suburban streets and in alleys, were laid on a 6-in. concrete foundation. In suburban streets 4 ins. of concrete were used and in alleys broken stone. Brick pavements did not find much favor, partly from the fact that poor material had been used. At present wood block pavement was favored. Yellow pine blocks, 4 × 6 × 9 or 12 ins., creosoted with 12 to 14 lbs. of creosote per cubic foot, laid on a 6-in. concrete foundation were used. The final paper on street paving was by Mr. E. B. Guthrie, Chief Engineer, Buffalo, N. Y., and was entitled "Cost of Repairing Asphalt Pavements." As the information given was largely in the form of tables it will be considered separately at a future time.

### Discussion.

The discussion which took place on the papers presented was somewhat discursive, and neglecting its order of occurrence it is here collected under separate heads as far as practicable.

Asphalt Pavements.—Mr. N. P. Lewis, in response to questions, stated that chemists were not agreed as to what chemical action took place when carbonate of lime was added to asphalt. Physically it filled the voids, made the pavement harder and consequently tended to make it more slippery. The experience with the testing laboratory at Brooklyn had not yet been long enough to enable a certain determination whether a sample was lake or rock asphalt, but it indicated that the relative percentages of petroline and asphaltine might be a good determination. The use of asphalt in Brooklyn had been too short to enable a determination as to whether rock or lake asphalt was the better, but the major part of the pavements now laid were Trinidad lake asphalt. The cost, exclusive of curbing, of a pavement made up of a 6-in. concrete foundation, ½-in. cushion coat, and 2 ins. wearing surface, was $2.54 per sq. yd. for a 24-ft. roadway; cost of a 1-in. cushion coat and 2-in. wearing surface laid over old cobblestone pavement on a 34-ft. roadway, was $1.84 per sq. yd.

Mr. L. W. Rundlett, City Engineer, St. Paul, Minn., stated that the lowest cost for asphalt pavement in that city had been $1.95 per sq. yd. A five-year guarantee was required. Mr. A. D. Thompson, City Engineer, Peoria, Ill., stated that in Peoria, Ill., asphalt pavement, 6-in. concrete foundation, ½-in. binder, and 2-in. wearing surface cost from $1.84 to $1.90 per sq. yd. A five-year guarantee was required. Mr. E. B. Guthrie, Chief Engineer, Buffalo, N. Y., stated that for the last two or three years the asphalt paving in that city had cost about $2.45 per sq. yd. Mr. Geo. H. Benzenberg, City Engineer, Milwaukee, Wis., stated that pavement with a 6-in. concrete foundation, 1-in. binder, and 2-in. wearing surface, excluding curbing and deducting spaces for manhole covers, etc., but including grading, cost from $1.95 to $1.99 per sq. yd. This was pavement in streets having no street railway tracks, but in streets having such tracks, 7 ins. of concrete, 1-in. binder and 2-in. wearing surface was used, with a 20-in. brick gutter on each side, and cost $2.31 to $2.34 per sq. yd. This included laying a granite course along the inner line of tracks, stone being furnished by the railway company. The railways were also required to maintain the pavement between tracks and 1 ft. outside of outer rails. If the stone courses were not used unsatisfactory results followed. These also occurred when the cross ties and rails were not laid on a concrete foundation as the oscillation broke up the pavement.

The discussion closed with a brief consideration of what was meant by an asphalt pavement in good repair, which was called out by the fact that trouble occurred with asphalt paving companies as to the meaning of the term when turning over pavement to the city at the end of their guarantee. The opinion of those most familiar with the subject was that rigid specifications should be drawn to cover this point, and a resolution was adopted by the convention asking that a special committee be appointed to present such specifications at the next annual convention.

Brick Pavements.—Practically the whole discussion turned upon the testing of brick and the rumbling of brick pavements, the first drawing out the usual variety of conflicting opinion. Mr. M. L. Holman, of St. Louis, Mo., stated that that city had gone thoroughly into the subject of testing paving brick for the purpose of evolving a practical commercial system of testing. They had even laid pavements and driven horses and wagons over it continuously to discover the real action of traffic. In the laboratory their tests and the results from them had been as follows: The absorption had been rapid at first, but became slower the longer the time, and continuing to a small extent for some months. From the experiments, he concluded that 48 hours could be considered to give a fair test. Abrasion tests were carried out in a 26-in. × 4-ft. foundry tumbling barrel. It was found that by plotting the results a regular curve was obtained which was comparable with other curves obtained from bricks of the same manufacture but not with those of other manufacture. In cross breaking tests it was found that bricks of good quality broke at the center of the span, but poor quality bricks broke irregularly, the break following lines of defect. To determine the interior structure an apparatus had been devised to split the brick. Good quality bricks split straight, while the fracture in those of poor quality followed the lines of defect. Tests were now being made to determine the effects of freezing by artificially freezing the bricks from the top down, just as such freezing would occur in the pavement. As the result of all experiments, he had excluded all but the cross breaking and abrasion tests for practical use. He did not think that the interior of a brick which absorbed more than 2% of water was thoroughly compacted and free from laminations.

In respect to the rumbling of brick pavements Mr. N. P. Lewis stated that they had experienced trouble in Brooklyn, N. Y., and attributed it to the fact that the sand cushion contained frost when the pavement was laid, and when in warm weather the sand thawed a void was left under the pavement. His opinion had been confirmed by reports from other cities, and he could not bring himself to believe that grout filling and expansion had much to do with the trouble. Mr. A. D. Thompson, City Engineer, Peoria, Ill., considered that if the pavement was properly laid no trouble from rumbling need be had with grout filling or any other kind of filling.

Wood Pavements.—The paper describing the adoption of a wood block pavement in Indianapolis and the approval of its continued use by the Board of Public Works of that city raised a somewhat heated discussion. A number of the members were disposed to condole the city on the mistake it had made and cited numerous cases in which wood block paving had been a total failure in this country. It developed in most instances, however, that the cities having these sad experiences had adopted wooden block because it was cheap, if constructed as it usually is constructed in America, and the sand and plank foundations, untreated blocks of cedar and white pine, and improper joint filling, had worked the failure which might have been readily anticipated. In a brief discussion Mr. Geo. H. Benzenberg insisted upon the fact that such wooden block pavements as were usually constructed in this country could not be justly compared with pavements made of sound creosoted or otherwise treated blocks, laid on a concrete foundation with proper attention to joint filling, such as are laid in European cities. He, however, considered that no advantage in cheapness of cost could be expected in wood pavements properly laid. Mr. F. W. Cappelen, City Engineer, Minneapolis, Minn., considered wood block inadvisable on account of cost of maintenance. Where, however, the people were willing to stand this expense no better pavement could be desired. In Europe it was tacitly understood that the blocks were to be replaced every four or five years, but for the other advantages secured the people were willing to pay for this maintenance.

Opening of Pavements.—Although the discussion was quite voluminous on the question of regulating the opening of street pavements by persons and corporations desiring

to make gas and sewer connections, etc., it consisted mostly of a relation of troubles and of stating the urgency of more stringent laws. Mr. N. P. Lewis, of Brooklyn, N. Y., stated that it was the practice of that city when about to lay a new pavement to give 15 days' notice to all persons to complete their improvements in advance. After the pavement was once laid no permits were allowed for a period of five years for asphalt and brick pavements, or three years for other kinds. This could not be enforced. At present the cost of permits for street openings is $13 from March to December and $18 for the remainder of the year. In the city of New York the least charge was $4.50 per sq. yd. and no permit was granted for less than a 4-sq. yd opening. In further discussion it was developed that many states had laws authorizing connections to be carried to the curb lines at the time of constructing the pavement.

Electric Street Lighting.

The consideration of this subject comprised an elaborate committee report and a paper by Mr. J. A. Cabot, City Electrician, Cincinnati, O., entitled the "Municipal Control and Inspection of Electrical Construction in Cincinnati." The report consisted of a tabular statement of plant, operating expenses, cost, etc., of the electric street lighting plants in upwards of 100 American cities and will be considered in a future issue. Only a brief discussion followed the report and papers, and this consisted mostly of replies to questions regarding misunderstood points in the report and paper.

Sewerage and Sanitation.

The committee on this subject had no formal report to present but had secured two papers which were then read. Capt. Lansing H. Beach, U. S. Engineer Corps, Washington, D. C., presented the first of these under the title of "Construction of Pipe Sewers to Prevent Root Intrusion." In the city of Washington, D. C., the great abundance of shade trees had caused much trouble from the roots getting through the joints into the sewers and otherwise disturbing them, and a special construction had to be adopted to overcome the difficulty. The plan adopted was to bed the pipe in concrete on the bottom and sides and at the joints to carry a 4-in. thick ring of concrete over the top. Hub and spigot joints were not used in this construction, which had been very efficient for the purpose intended. The second paper under the head of sewerage was read by Mr. G. L. Clausen, Superintendent Sewer Department, Chicago, Ill., and described the "Sewers and Sewage Disposal of Chicago." The paper was a relation of subject matter already familiar to our readers. The discussion on the papers proper was brief and needs no extended mention. Mr. Geo. H. Frost, of Engineering News, described at some length the sewage disposal system constructed under his direction at Plainfield, N. J., and already fully described in these columns, and called attention to the fact that with the growing stringency of legislation regarding the pollution of streams, this and similar methods of disposal should be carefully studied by engineers.

Water-Works and Water Supply.

The report of the committee on this subject was read by the Chairman, Mr. H. Van Duyne, Newark, N. J., and consisted in a summary of the features particularly needing study. Among these the report mentioned particularly, growth of algae and other organisms, trouble from anchor ice at all gate houses, and sewage pollution. Four papers followed this report, of which those on "Water-Works at Nashville, Tenn.," "Filtration of Water Supply at Davenport, Iowa," and "Biology of Water, Microscopical Organisms and the Determination of Quality," covered features already made familiar to our readers in previous issues. The fourth paper was by Mr. John W. Hill, M. Am. Soc. C. E., Cincinnati, O., and took up the question of the purification of "Water Supply in Eight Cities in Relation to Typhoid." A description of the methods of water purification at Berlin, Zurich, The Hague and Liverpool was given and compared with the lack of such methods in New York, Philadelphia, Cincinnati and Chicago. Comparisons were drawn between the death rates by typhoid of these cities, in which perhaps the most notable fact was that Chicago showed the worst conditions, its typhoid death rate being for the past five years 10½ times that in Berlin. No discussion followed these papers.

Under this same head came the paper on "Method of Treating Garbage in Milwaukee," by Dr. Walker Kempster, Commissioner of Health. This plant has already been fully described in Engineering News, as has also the plants at Buffalo, N. Y., and Cincinnati, O., which were described in the discussion which followed. The discussion brought out nothing concerning these plants which we have not given in the articles mentioned.

City Government.

Under this head came two reports of committees on "Taxation and Assessment" and "City Government and Legislation," both of which were very elaborate and entered into the general discussion of broad questions of law and municipal management too extensively to be taken up here. They elicited no discussion.

Election of Officers.

The election of officers for the society for the coming year took place on the second day of the convention and resulted in the following selections: President, August Herrmann, President Board of Administration, Cincinnati, O.; First Vice-President, E. B. Guthrie, M. Am. Soc. C. E., Chief Engineer, Buffalo, N. Y.; Second Vice-President, Wm. R. Kerr, Health Commissioner, Chicago, Ill.; Third Vice-President, E. Adam, Engineer Board of Street and Water Commissioners, Newark, N. J.; Secretary, D. L. Fulton, Superintendent of Sewers, Allegheny, Pa.; Treasurer, J. L. Kennedy, Nashville, Tenn.; Finance Committee, L. W. Rundlett, City Engineer, St. Paul, Minn.; A. F. Monroe, Chairman Public Works, Omaha, Neb., and F. J. O'Brien, Superintendent Public Works, Oswego, N. Y.

Committees were appointed to report at the next annual convention upon the following subjects: Street Paving, Electric Street Lighting, Sewerage and Sanitation, Water-Works and Water Supply, Taxation and Assessment, City Government and Legislation, Disposition of Garbage and Street Cleaning, Reviews. The place selected for the next place of meeting was Nashville, Tenn.

Excursions and Entertainments.

Several excursions and entertainments were arranged by the local committees for the pleasure of the convention members. On Oct. 15 an excursion along the line of the Chicago Drainage Canal was tendered by the trustees of that work, and on Oct. 17 an excursion to the water-works intakes by boat and a coach ride through the South Side parks and boulevards took place. On the evening of Oct. 16 a banquet was tendered to the members by the local committee. These various entertainments were participated in by the majority of the delegates present and were thoroughly enjoyed.

## BOOK REVIEWS.

A TEXT-BOOK ON GAS, OIL AND AIR ENGINES, or Internal Combustion Motors without Boiler.—By Bryan Donkin, M. Inst. C. E. Second edition. Revised and largely Rewritten. London, 1896. Chas. Griffin & Co., Limited. 8vo.; pp. 500; 154 illustrations.

This work, by a well-known English engineer, is the standard work on its subject. The present edition brings it up to date. It is a very complete treatise, including the history, theory, practice, bibliography, list of patents, etc., A table in the appendix contains the principal results of 147 tests of gas, oil and air engines from 1878 to 1895.

A PRACTICAL TREATISE on Segmental and Elliptical Oblique or Skew Arches, setting forth the principles and details of construction in clear and simple terms. By George Joseph Bell, County Surveyor and Bridge Master of Cumberland. London and New York. E. and F. N. Spon and Spon & Chamberlain. 8vo.; 125 pp.; 8 plates. $8.40.

The author aims to simplify the rules of construction for oblique arches, and devotes pages of text to a description of the mathematical processes to be gone through with. Close attention to these directions will doubtless enable an engineer to build an oblique arch—if he must, but the plates are chiefly elevations of plans of such arches as built and have little value to the student. It is to be regretted that the author did not indulge more in illustrative matter relating to the practical application and the appearance of the various necessary templates. The construction of arches of this type is rarely called for in the United States; and when the occasion does arise both the engineer and the stone-cutters have to be initiated in what may be simple work to Mr. Bell. This detail is just what he has omitted, and it is the only part that would warrant a new treatise on a rarely applied art, in this country at least.

ELEMENTS OF MECHANICS, including Kinematics, Kinetics and Statics. With Applications. By Thomas Wallace Wright, M. A., Ph. D., Professor in Union College. New York: D. Van Nostrand Co. London: E. & F. N. Spon. 12mo.; pp. 372. $2.50.

This book, the author states in the preface, is a completely rewritten edition of his "Text Book of Mechanics." The sections on graphical methods have been extended. Machines have been discussed in greater detail. New problems and illustrations have been added throughout. To each chapter is appended a series of examination questions on the text preceding or capable of being easily deduced from it. No mathematics has been introduced beyond the elementary principles of geometry, trigonometry and the calculus. The book is so arranged that the sections involving calculus may be omitted without disturbing the continuity, and thus a more elementary course be taken. The British and metric gravitation systems of units and also those of the C. G. S. system, with their dimensions, are all fully treated.

We find a great deal to commend in this book, and in the hands of a skillful teacher it should prove an excellent text book. The explanations are in general very clear, and the great number of practical examples for numerical computation will prove an admirable exercise for the student. We regret, however, that the author has fallen into the pitfall which has been prepared for all modern writers of mechanical text books by those scientists who have injected into the literature of the subject new terms and definitions and new methods of theorizing. With the various gravitation units, British and metric, the absolute or C. G. S. (centimeter, gramme second) and the M. K. S. (meter, kilogramme second) with their "dimensional" formulas, in which force is defined as a function of length, mass and time with a negative exponent, and with a great number of new units, such as megalergs, kines, boles and spouds, it is no easy matter for any author to steer a clear course, and at the same time make his text consistent with his definitions and clear enough to be understood without a great deal of labor. That the present author has made an earnest effort in this direction is apparent, but he has not been very successful. In his preface he tells us that he uses the term "centrifugal force," although there are objections to it, because as all engineers use the term it will not do to ignore it. On the other hand, he confines the use of the term mass to the absolute system of units only. It is not easy to see why he does not use it in the sense in which all engineers who have studied Rankin use it, namely, as the quotient of the weight of a body divided by the factor g, or the acceleration due to gravity. With the more recent writers he begins the study of the subject with velocity instead of with force. The second chapter treats of Newton's laws of motion, and in it we find his first definition of force in these words:

> From the law (Newton's first law) we also learn that by the term force is meant a cause of change in motion, not in the sense of moving agent, but in the sense of antecedent. Force is thus not to be regarded as the cause of a state of motion, but of a change of state, from rest to motion, motion to rest, or to an alteration of motion—in a word, of acceleration. Whenever force acts an acceleration of the motion of the body acted upon is produced.

To say that force is not to be regarded as the cause of a state of motion, but as the cause of a change of state from rest to motion, is a verbal splitting of hairs which is highly objectionable in a work of this kind, but the last sentence in the above quotation is unpardonable, for it is untrue except when the force is unbalanced and the body is free to move.

Under Unit of Energy we find the following:

> The unit of energy must be the same as the unit of work. In the British system the unit is therefore the foot-pound. Note that unit kinetic energy is not the energy of unit weight (1 lb.) moving with unit velocity (1 ft. per sec.), but only one-half that quantity.

The expression "unit kinetic energy" is a bad example of the prevailing tendency to define "units" of every conceivable kind, compound as well as simple. If the unit of energy, kinetic or other, is one foot-pound, and the formula for energy is $\frac{1}{2} w v^2 \div g$ then the energy of a body whose weight is 1 lb. and whose velocity is 1 ft. per second is $1 \div 2 g$ foot-pound. According to the author's statement, "unit kinetic energy" is one-half of this quantity or $1 \div 4 g$. No doubt he does not mean this, but this is our understanding of his language.

Further on we find this, under Conservation of Energy:

> It is perhaps more in accordance with the spirit of modern science to consider space, time, matter and energy as the fundamental concepts of mechanics rather than space, time, matter and force. * * * The latter method, which is that followed in this book, is given as being more readily appreciated by the beginner. But as it involves difficulties from which the first is free it seems likely that the notion of energy will in time be adopted universally as the fundamental one rather than that of force.

We think the author has done well in following the second notion spoken of, in considering force and not energy to be the fundamental concept. If it is "more in accordance with modern science" to consider energy as the fundamental concept, then it seems to us that modern science is science run mad. Force, defined as anything which tends to cause motion, such as a push or a pull, is a fundamental concept which can be appreciated by any student, but energy, whether defined as F S, the product of the acting force into the distance through which it acts, or as $\frac{1}{2} M V^2$, or half the product of the mass into the square of the velocity, is a compound concept, and its measure can only be given in a compound unit, such as a foot-pound. Consider one of the simplest cases of mechanical action, an apple falling from a tree. We have as fundamental ideas in mechanics the matter, mass or weight of the apple, the attraction of gravitation, or the force which causes it to fall, the space or distance through which it falls, and the time during which it falls. We cannot calculate its energy without considering at least two of these elements, the weight and the distance, or the mass (weight $\div g$) and the final velocity.

We have expressed ourselves thus at length upon this subject because we consider it is high time that a protest should be made against one of the tendencies of "modern science," which is the introduction into literature of new and unnecessary terms, definitions which are lacking in clearness and precision, and in many cases contradict those which have been approved by the usage of generations of scholars, and "fundamental concepts" which are contrary to common sense. If there is any science which should be kept free from such innovations it is mechanics, a science which is practically as finished and unprogressive as geometry. No new facts are likely to be developed in it in the next century, and the method of presenting it which was in use 20 years ago can scarcely be improved on. The only change that can be made is that which is attempted by some writers who are introducing the innovations, and are apparently trying to make mechanics not a useful tool for engineers, but a branch of metaphysics, in which discussion of "concepts" takes the place of exemplification of facts.